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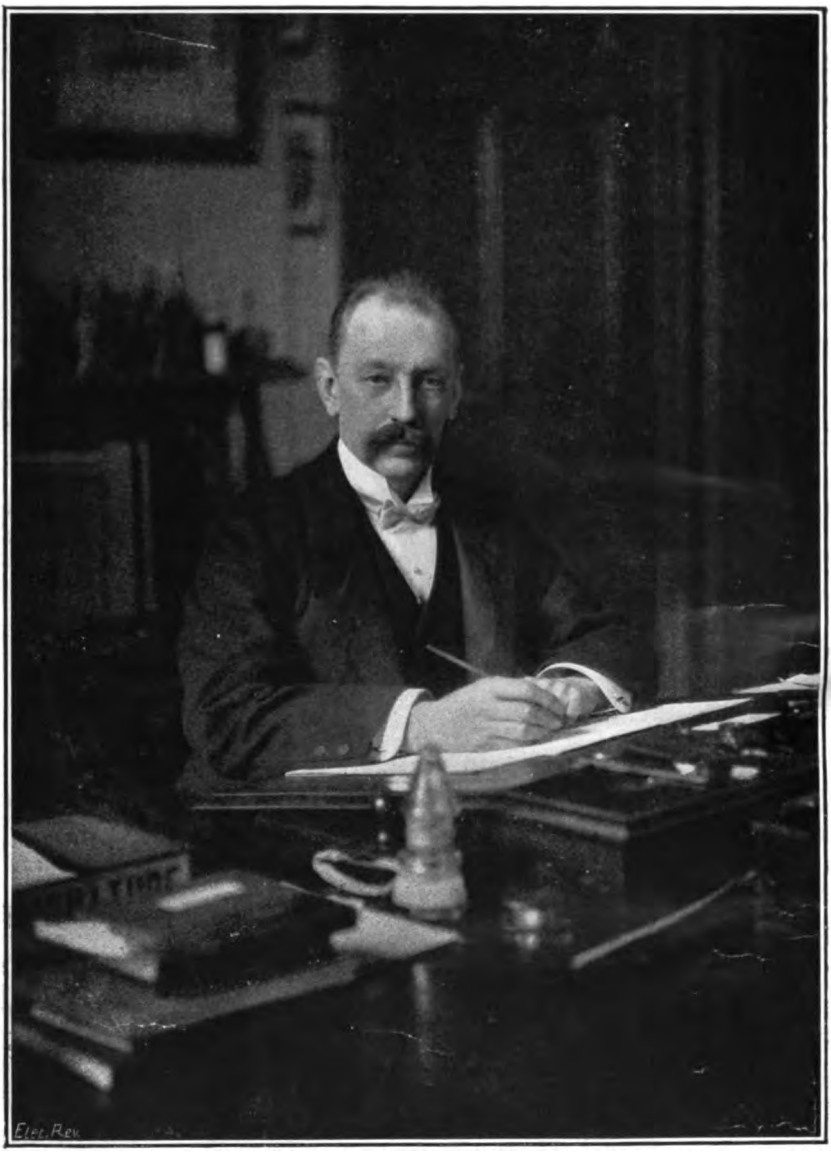

SIR JOHN GAVEY, C.B.

FIRST PRESIDENT

OF THE

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS

1905

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THE

Post Office Electrical Engineers' Journal.

FOREWORD.

The publication of this Journal is the result of the materialisation of ideas which have slowly but irresistibly permeated the minds of British Post Office Engineers during the last decade. Like the Institution of which it is the organ, it is built on foundations which have been well and truly laid, and we have no fears as to its enduring success. The response to our preliminary announcement by contributors and subscribers, even before time has allowed of the receipt of replies from the colonies, has far exceeded anticipations, so much so that it has been necessary to increase the original order to the publishers by 50 per cent. Those to whom our Journal will appeal seem to us to be arranged in five concentric circles:

1st—The members of the Institution of Post Office Electrical Engineers;

2nd—All Post Office Officials of the United Kingdom connected with telegraphs and telephones;

3rd—All telegraph and telephone engineers of the United Kingdom other than "Post Office";

4th—Colonial Engineers; and—

5th—All inhabitants of this world who are interested in telegraphs or telephones.

The contributions to the first number have been drawn from the first two circles only; they will not, however, be found to be lacking in interest to those in the outer circles.

We hope that the vigorous action which has thus been generated at the centre will produce a healthy reaction on the part of our distant colleagues. In some future number the history of the birth and development of the movement which has reached the present stage will be put on record, but for the present it is sufficient to point out that the advantages which members of the Institution have enjoyed during the last two years are widened and deepened by the publication of the Journal. The mutual intercourse which has hitherto been confined to a district is now made common to all. The audience which the Institution provided for the man with a message is by means of the Journal increased a hundredfold. It shall be our earnest endeavour to keep our pages open for the free and healthy discussion of all subjects relevant to our profession, and at the same time to secure that nothing unworthy shall sully them. We desire that the 'Post Office Electrical Engineers' Journal' may soon come to be recognised in the lives of its readers as a real factor for good and for progress.

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WORDS OF WELCOME

From Sir JOHN GAVEY, C.B., M.Inst.C.E.

A NEW Electrical Journal is commenced to-day which we hope will not only have a long and prosperous career, but which is destined to have a potent influence for good on the large body of men whom it is intended to represent directly. In view of the large amount of special electrical literature, which is now published, in addition to the very considerable space devoted to the subject in most engineering and scientific journals, it may be asked whether there is room for an additional publication devoted to one special branch of this great industry. The answer can only be an unqualified affirmative. As an art expands, and widens its sphere of usefulness, the need for specialisation becomes more urgently felt, and institutions and literature devoted to individual branches become necessary. When engineers were a limited body, with limited spheres of influence, one parent institution met all their requirements, but now there are scores of engineering societies. So with our own branch; even as recently as forty years ago telegraphy was the only existing branch of electrical engineering, and when the present Institution of Electrical Engineers was founded in 1871, with the title of the Society of Telegraph Engineers, it fully represented the whole of our interests. The widening of the electrical outlook was foreshadowed in 1880 when the Society made the first change in its name, and began to devote so much of its attention to the new processes and inventions, which had so much interest for, and were of such importance, not only to engineers, but to the world at large; but this very extension of its work tended to crowd out much that would have been of interest to telegraph engineers, many of whom thought that they were not fully represented by the enlarged society. The ultimate outcome of this feeling has been the successful foundation of the Institution of Post Office Electrical Engineers, and the edifice is now crowned by the inauguration of its official mouthpiece the POST OFFICE ELECTRICAL ENGINEERS' JOURNAL.

The scope of the new JOURNAL is wide and liberal. In the matter of descriptive and scientific articles and engineering abstracts it should fill a much felt want, as everyone in active service has experienced the difficulty in finding time, even when the means exist, to wade through the English and Foreign professional literature in order to keep abreast of the most modern views.

The JOURNAL also should be of inestimable value as an incentive to authorship. It has often been said that the best way to learn is to teach, and everyone who has attempted the latter rôle has realised how much he has himself benefited in the process; so in endeavour-

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ing to give a clear description of his experiences, and to marshal his ideas in logical sequence, every writer in our JOURNAL, in his efforts to impart his knowledge to his friends and colleagues, will find that he has widened his own horizon and that he has strengthened his own mental conceptions of the subjects that he has made his special study. Like the quality of mercy it may be said to be twice blessed, it blesseth him that gives and him that takes.

But, apart from these questions, in following the examples of other great national services by the establishment of our own professional JOURNAL, we shall do much to link up the widely-scattered officers of our branch, many of whom, owing to their isolation, are not only out of touch with their colleagues, but with the wider professional world, and are thereby debarred many opportunities of forming broad views on subjects immediately outside their own personal experiences.

In wishing hearty success to our new JOURNAL let us not forget that success will depend on our support, which should be given in an ungrudging spirit.

J. Gurney

NOTES AND COMMENTS.

ENGINEERING DEPARTMENT ANNUAL DINNER.

THE fact that the Annual Dinner of the Engineering Department has reached its fifth consecutive year may be taken as an assurance of its continued success and, it is hoped, of its growing popularity. Owing to the wide area over which the staff are necessarily scattered, attendance at the annual gathering must necessarily be greatly restricted, but there is but one opinion expressed by those who have been able to be present, and that is one of great pleasure and enjoyment. The advantages of social intercourse of this kind are great in every way, and the simple fact of the exchange of a few words between those who would otherwise but rarely meet is by no means an insignificant matter; especially pleasant it is to meet those who, through the inexorable age-limit, are no longer of the fraternity, but yet have a warm feeling towards the Department in which they worked so zealously, and for so many years. On each occasion of the dinner some important announcement has been made (in the course of the usual complimentary speeches) and this has almost come to be looked upon as an arranged part of the evening's proceedings; in the present case the announcement being that of the

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appointment of Sir John Gavey as Consulting Engineer to the Department. This appointment is generally recognised as being very necessary in view of the important issues at stake in connection with the coming transfer to the State of the National Telephone Company's system; the heavy every-day work of the Department, which is daily growing, requires unrestricted attention from the permanent Engineering heads, and this can now be given. Much appreciated will be the announcement that it is recognised that there has been a considerable amount of over-pressure of work amongst the staff, and that steps will be taken to largely alleviate it. Willing and loyal the members of the staff undoubtedly are, but there is, of course, a limit to physical endurance, and when this limit is passed work is bound to suffer, not only in regard to efficiency, but also in regard to economy.

The remark of the Postmaster-General that "I doubt if the enormous extent of the work carried on by the Engineering Department of the Post Office is appreciated outside" is unquestionably a true one. The general public have really but a very faint conception of the multifarious classes of work which the Department is called upon to perform; probably if they were told that the block signals on certain railways are maintained by the Department, the statement would be received with incredulity.

The Engineer-in-Chief, in responding to the toast of "The Engineering Department," expressed indirectly, but in no uncertain way, the necessity for members of the staff keeping well abreast of scientific progress. This might with advantage be taken well to heart.

Central Battery Telegraphs.

The articles on the Polarised Sounder and on the Common Battery Duplex contained in this issue will recall to our readers the rapid and striking development of central battery telegraph working which has been effected in the Post Office within the past few years. In the application of central battery working to telephony, we on this side of the Atlantic have been more or less humble followers of the practice of our American cousins so far as main principles are concerned, but in the telegraphic field the Post Office has the distinction of being the pioneer. It may be said that the "closed circuit" system of telegraphy, which has for many years been in general use in countries where the lines carry so small a volume of traffic that many stations can be grouped on a single wire, is, in a sense, a central battery system, since it is unnecessary to maintain a battery at each of the stations connected. But in the wider sense of working large groups of circuits, radiating from busy centres by means of centralised sources of energy, little or nothing appears to have been done outside this country.

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The first step taken here was one on a scale of considerable magnitude, when it was decided to equip the new London Telegraph Intercommunication system on a Central Battery plan, and thus abolish at one stroke the scattered groups of batteries on more than 1000 telegraph circuits. About 12,000 primary cells were thus replaced by a single group of accumulators installed in the Central Telegraph Office, which served alike for switch circuits, direct C.B. simplexes, and C.B. duplexes of special design, with a consequent maintenance saving of more than £1000 a year. At the same time the polarised sounder was re-designed and introduced on all the circuits as an integral part of the scheme, since which it has ceased to be a plaything, and, as the instrument adapted above all others for central battery working, has taken its place in the everyday life of the British Telegraphist. Of the entire success of this bold experiment from an engineering standpoint there has never been the slightest question, and the simplification effected in the equipment and wiring of large telegraph offices throughout the wide-spreading Metropolitan Area has been a very striking one. In place of a basement filled with battery boxes and a mass of wires, we now have, in most large offices, a single lead-covered cable entering the building from the street, and running unbroken to the instrument tables, where its conductors are distributed to the various working instruments.

Equally satisfactory results are attending the introduction of central battery working on the shorter lines which radiate from all large offices throughout the country. At many of these offices secondary cells were already in use, and no further battery provision for central battery working was required, but at many others, where secondary cells are not available, the necessary power is simply and satisfactorily provided from a few groups of bichromate cells. The saving represented by the abolition of batteries in the small and relatively inaccessible provincial offices served from these centres has exceeded, many times over, that effected in London. The system of double current working from a single pole battery permanently connected to the line at the central office, and the method of producing reversing condenser impulses, whereby the polarised sounders at all stations on the line are actuated without any reversal of the battery itself, are features of decided novelty which are still being developed in new directions, and which are being copied by several other administrations which, like the Post Office, are devoting much time and thought to the reduction of cost of equipment and maintenance.

We hope to keep our readers in close touch with progress in these matters.

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THE POLARISED SOUNDER.

By C. C. Vyle and E. V. Smart.

In the first days of telegraphy the sounder was placed in the main circuit. It was actuated by currents in either direction, positive or negative, *i. e.* it was single current in action. The strength of current required, however, was very great, and this limited the distance over which telegraphy was practicable. With imperfectly insulated lines an enormous voltage would have been necessary to ensure the requisite current passing through the receiving instrument. This difficulty led to the invention of the relay, which, similar in action to the sounder, but with the moving part of lighter construction and the coils possessing a greater number of convolutions of wire, was actuated by comparatively small currents. The moving part, when the armature was attracted, completed a local circuit in which the sounder and a battery were placed. The sounders used in the local circuits were generally wound to 20$^{\omega}$, but on the introduction of secondary cells it was necessary to increase the resistance of the sounders to 900$^{\omega}$, on account of the variation in strength of current when the number of local circuits closed was continually changing. A much greater distance was bridged over by the use of the relay.

Improvements in relays, to increase still further the working distance, followed, and among them was the double current or polarised relay. This was much quicker in action than the single current relay, and required even less current to work it. The armature of the polarised relay is inductively magnetised, and a negative current sent through the coils in one direction causes it to be attracted to one side, while a positive current sent through the coils in the same direction causes it to be attracted to the other side. When the armature is in one of these positions—a prearranged position—the local circuit is closed. Polarised relays, besides requiring local batteries in connection with their use, are delicate instruments for the unskilful to adjust, and it was to secure the advantages of a polarised relay that attention was turned to polarising the sounder itself, so that it might be used without relays in positions where skilled attention was not available, and to avoid the use of local batteries.

It will be noticed that the polarised sounder of to-day allows us to revert to the simple system of the early days of telegraphy with an efficiency which hitherto has only been obtainable by a comparatively costly equipment.

Before describing the latest form of polarised sounder it will perhaps be as well to refer briefly to the old form.

A sounder may be polarised in two ways: either the armature is

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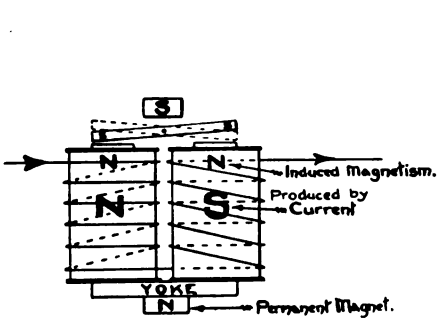
magnetised, or the core of the electro-magnet is magnetised. It has been the practice hitherto to magnetise the armature. This has generally been done by induction, it being well understood that a short magnet of such dimensions as a sounder armature usually is, would soon lose its magnetism if it were not for the protecting influence of some powerful magnet. In the latest form of polarised sounder however, the core of the electro-magnet has been magnetised with excellent results.

Polarised sounders of the former type are similar in appearance to the single needle instrument. The sounding pieces are fixed on a dial, and the striking piece moves to the right and left against them.

The armature is magnetised by induction by a powerful permanent magnet, one of whose poles is near the middle of the armature. This makes the extremities of the armature of similar polarity. A current passing through the coils in one direction causes one end of the armature to be attracted, the other repelled. A reversal of current causes the end formerly repelled to be attracted, and that formerly attracted to be repelled. A sketch will explain (see **1**).



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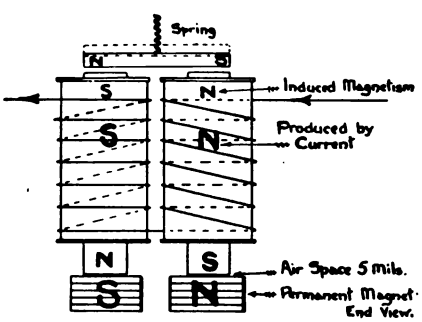

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This type had two objections urged against it :—

(1) The signals were liable to sound reversed.

(2) The sound emitted was said to be irritating.

To overcome these objections a new polarised sounder was designed by Mr. C. C. Vyle. As previously stated, the cores of the electro-magnet are magnetised; these in turn, however, magnetise the armature by induction.

The instrument, in appearance, is identical to that of the ordinary pony pattern sounder (see **2**).

A permanent magnet is placed in the base of the instrument and the cores are thus inductively magnetised. If, in looking at the instrument, the adjusting screw be placed on the left, it will be found that the north pole is the nearer to the observer. The magnet is made sufficiently powerful to withstand any tendency to reversal

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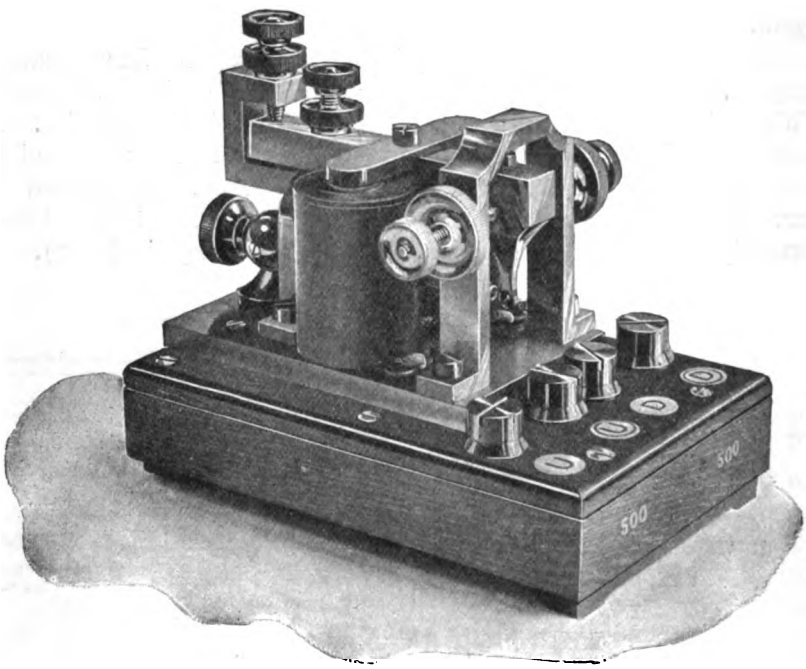
produced by a current through the coils. An air space or non-magnetic disc breaks the magnetic circuit between the permanent magnet and the cores; this is essential for good working.

To illustrate the value of the induced magnetism the following may be considered:—The strength of the magnetism induced in the cores of a 500ω + 500ω polarised sounder is about equal to that which would be induced by a current of 18 milliampères through both coils. Tension must be put on the spring to make the instrument neutral, *i. e.* the armature must remain up or down when moved by hand. We now have the instrument in a very sensitive



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condition, and a glance at the curve of magnetisation (4) will show the effect of making changes within certain limits. A slight marking current, adding to the magnetism of the cores, will overcome the spring, or a slight spacing current, reducing the magnetism in the cores, gives the spring the mastery. The position may be likened to a pair of scales, magnetism in one pan and spring tension in the other, the magnetism to be used as the weights, but the beam is so balanced that the slightest alteration in the weights (increase or decrease) produces a pronounced effect.

For comparison with an ordinary unpolarised sounder it is only necessary to quote the currents allowed for the respective instruments. The ordinary sounder (900ω) is allowed 20–26

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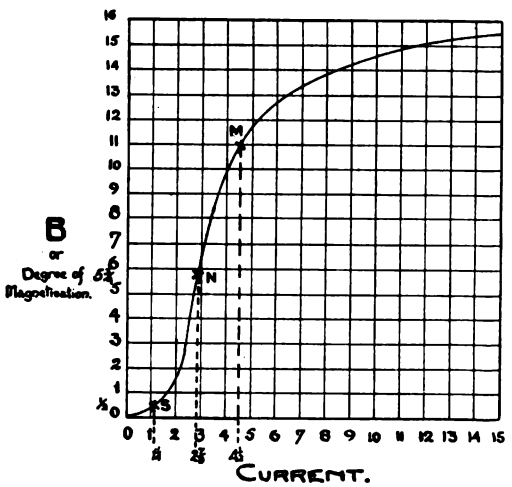
milliampères to give working signals. The polarised sounder ($500^{\omega} + 500^{\omega}$) is allowed 10 milliampères to produce the same. An ordinary sounder is single current in action only; but a polarised sounder is actuated by single current or double current, and may be worked by condenser impulses. A polarised sounder $500^{\omega} + 500^{\omega}$ can be actuated by $\frac{1}{2}$ milliampère; 3 milliampères should produce Morse characters at twenty words per minute, and 10 milliampères gives strong, loud working signals. The standard adjustment is as follows:—The distance between the armature and cores when the armature is down should be 8 mils., while the distance between the lever and the upper limiting stop, with the armature in the same position, should be 16 mils., and with this adjustment the instrument can be worked with currents



N = Normal condition of magnetisation of the Polarised Sounder. M = Condition of magnetisation of Polarised Sounder when a marking current passes through the coils. S = Condition of magnetisation of Polarised Sounder when a spacing or demagnetising current passes through the coils.

ranging from 3 to 40 milliampères without altering the adjusting screw. By increasing the tension the instrument will respond correctly to very high values indeed.

The inductance of the instrument is 62 henrys. This is a very useful property, especially in view of the great extension of underground work. Owing to its balancing the capacity of a great portion of the line it will enable many circuits, which previously were balanced by means of triple condensers and condenser coils, to be balanced by means of a single condenser.

When the first long underground circuits were established considerable difficulty was experienced owing to induction. The circuits running parallel for many miles reacted upon each other, causing

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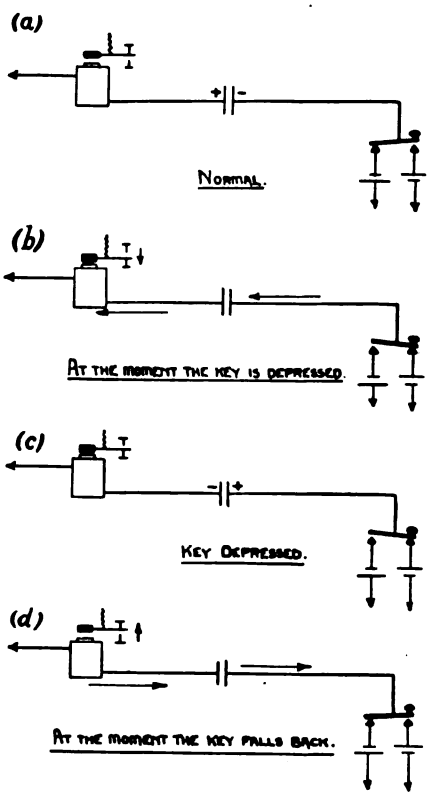
unpleasant chattering of the sounder when a circuit was idle, and mutilating to some extent the working signals. One or two arrangements to overcome this were tried, but the substitution of the standard relay and local circuit by a polarised sounder was found to be most effective and economical. Not only does this overcome the effects of induction, but it also allows the balance of a duplex circuit to vary considerably without necessitating a re-balance.

In one case it was found possible to work wheatstone at 150 words per minute on one wire of a pair in the northern underground from



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London to Liverpool, while a polarised sounder duplex circuit on the other wire was unaffected.

Condenser working.—One of the advantages of a polarised sounder is its applicability to condenser working. How this is accomplished may be of interest. The sounder is adjusted to the neutral position previously referred to (see 5*a*). The space between the limiting stops may be considered as being divided into two portions; the upper portion is under the control of the spring, the lower portion

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under the control of the magnetism. When the key is depressed (5*b*) a momentary current flows, charging the condenser. This current produces a preponderance of magnetism and causes the armature to be brought sharply down, where it remains (5*c*), not by virtue of any current continuing in the coils, but by being within the space controlled by the magnetism. To terminate the signal, be it dot or dash, it is only necessary for the key to rise (5*d*), discharging the condenser or charging it in the reverse direction. This produces a momentary discharge current in a direction to reduce the magnetism; the spring asserts itself and retracts the armature.

At the present time the polarised sounder is in use on many long distance underground circuits, viz. London to Glasgow (400 miles), London to Liverpool, etc. It is used on the London Intercommunication Switch and the Metropolitan Central Battery duplex circuits; it is also used on Central Battery Condenser Omnibus circuits. Practically every slow-speed Morse circuit of reasonable length can be worked successfully with it.

As it is usual to provide a current of 15 to 20 milliampères to work a standard relay when the coils are in series, it will be seen that with the same allowance the polarised sounder has a margin of 50 per cent. for working signals.

To sum up the properties which commend the Vyle polarised sounder: First, its extreme sensibility, due to the value of the induced magnetism, this being in the middle of the steep part of the curve of magnetisation; and in a second degree to the large number of convolutions in the coils. Second, its great inductance. Third, its insensitiveness to fleeting currents that would operate relays. This is due to the mechanical inertia of the armature, the weight of which is very heavy compared with that of a relay armature.

This manner of polarisation has also been adopted for polarising Morse printer instruments, double-plate sounders, relaying sounders, and other receiving instruments.

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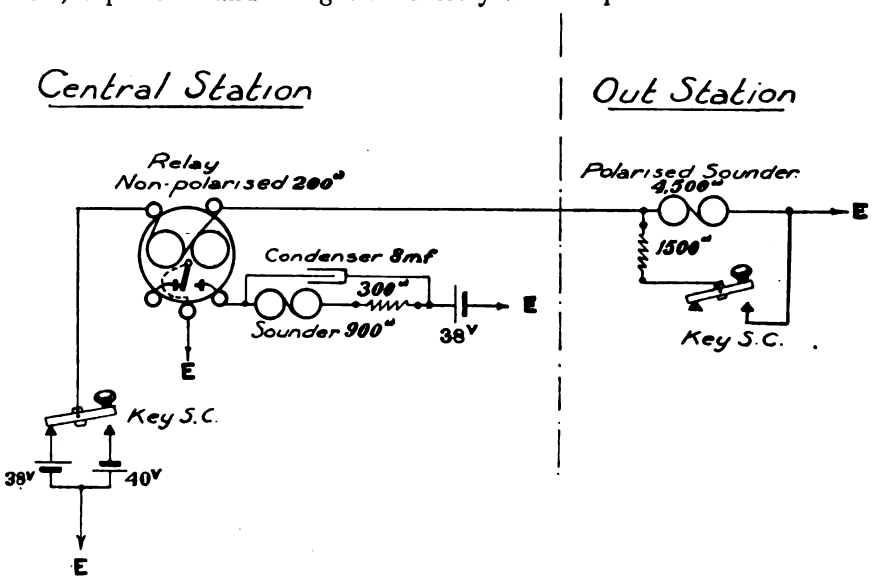
THE COMMON BATTERY DUPLEX.

By CHAS. E. HAY.

BEFORE entering into a description of the common battery duplex recently adopted by the British Post Office, it will be as well to review the system formerly in use in order to fully comprehend the difficulty presented by the problem of working duplex from a battery or batteries placed at one end only of a telegraph line, and to indicate the progress which has been made in this branch of common battery working since its introduction some few years ago.

In the original system, a theoretical diagram of which is given in 1, a positive and a negative battery were required at the central



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station for the purpose of sending to line reversals of current which operated the receiving apparatus at the out station, but were not of sufficient magnitude to operate the non-polarised relay at the central station, the armature of the relay being biassed against the currents by means of a helical spring. An increase of current effected by means of the key at the out station shunting the high resistance sounder with a resistance of 1500 ohms, created a magnetic force in the relay at the central station sufficient to overcome the force exerted by the spring, and therefore operated it. The current in the out station receiving apparatus was not sensibly affected when the shunt was applied, and in consequence the signals were satisfactory in both positions of the key at that station. At the central station, however, when its relay armature was in a "marking" position, a reversal of the current allowed the tongue of the relay to

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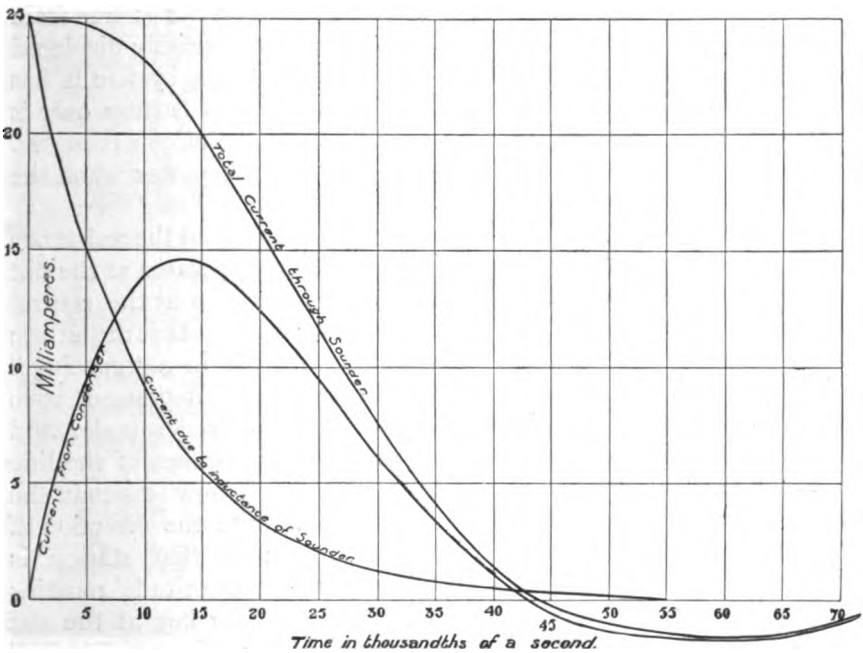
"kick" off the marking stop, causing the current in the local circuit to cease for a short interval of time, and consequently breaking the signals on the local sounder. Obviously this defect was extremely serious, and presented a problem not easy of solution. The manner in which the defect was covered up—it has never been remedied—affords a remarkably interesting example of the value of a knowledge of the laws governing transient currents of electricity. On reference to the diagram (1) it will be seen that the local sounder is joined up in series with a resistance of 300 ohms, both being shunted with a condenser of 8 microfarads capacity. The condenser is charged when the tongue of the relay comes in contact with the



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marking stop, and remains charged as long as they are in contact, but when the tongue "kicks" the condenser is allowed to discharge, and sends a current through the resistance of 300 ohms and the sounder, thereby maintaining the continuity of the signal. Figure 2 represents a curve showing how the current in the local sounder varies with time from the instant the tongue leaves the marking stop. The curve has been worked out on the supposition that the voltage applied is 40 volts, the resistance in series with the sounder 700 ohms, and the inductance of the sounder 16 henrys. It will be seen that current flows through the sounder for 45×10^{-3} seconds after the tongue leaves the marking stop, and is of considerable strength for half that period of time. If, therefore, the time which elapses

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between the tongue leaving the stop and returning to it does not exceed about 30×10^{-3} seconds the continuity of the signal is not broken, and satisfactory working results. In practice, when the key at the central station is closely adjusted so as to make the time as short as possible in changing from a voltage of one sign to that of another and when the rate of sending is normal, no difficulty is experienced. Owing, however, to the objection of manipulating a closely adjusted key and the impossibility of obtaining a constant rate of sending, this system of common battery duplex was found imperfect, and it was recognised that some other principle of working must be discovered.

The following system devised by the present writer is free from the defect just described, and it has now almost entirely displaced the older system. It differs in every respect from the system it has superseded. Diagrams are shown in Fig. 3. One battery only is required, and it is joined up permanently when the circuit is in use. Tumbler switches are provided for cutting off the power when the circuits are shut down.

Normally, owing to the bridge arms being equal, and the resistance of the line together with the resistance of the apparatus at the out station being greater than the 1250 ohms resistance at the central station, a current flows through the receiving apparatus at the latter; and the wiring is so arranged that this current is in a "spacing" direction. When the key at the out station is depressed 1000 ohms is cut out of circuit—one coil of the polarised sounder and the 500 ohm resistance coil—consequently the resistance of the line plus the remaining resistance of the apparatus is now less than the 1250 ohms resistance at the central station, hence the direction of the current through the receiving apparatus at that station is reversed, and, as will be shown presently, its magnitude remains approximately unchanged. The depression of the key at the out station causes the potentials at the terminals of the polarised sounder to change, but it is arranged that their difference remains constant. The receiving apparatus at the central station is therefore operated by reversing the direction of the current in it, while the receiving apparatus at the out station is unaffected. That there is no change in the difference of potential across the polarised sounder at the out station in all positions of the key there, is only absolutely true when the key at the central station is depressed. There is a slight change in the difference when the key at the central station is not depressed, but it is of no material consequence, as the out station apparatus is not then recording a signal.

The depression of the key at the central station joins the battery direct to the split of the polarised relay; the current in the line is therefore increased, and it is this increase which operates the

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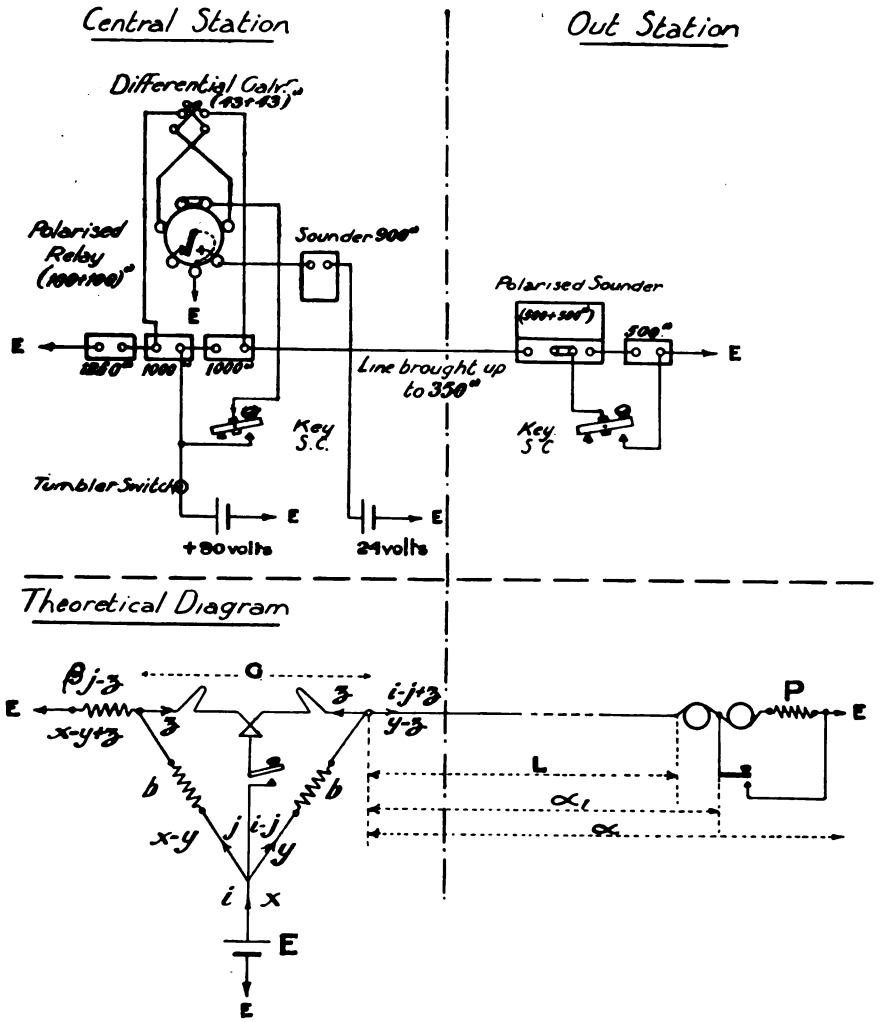
receiving apparatus at the out station. The direction of the resultant magnetic induction in the relay, due to the current splitting differentially through its coils, is not affected, as its components, which are proportional to the currents in the coils, depend entirely on the relation between the resistances on each side of the bridge arms, and, as already shown, this relation is controlled by the



3

operator at the out station. In order to render it unnecessary to bias the polarised sounder at the out station against the permanent current which flows through its windings, it is joined up in such a manner that the magnetic induction in its cores due to the polarising magnetic force is in opposition to the induction due to the almost equal magnetic force created by the permanent current.

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Having described the working of the system, perhaps it would now be of interest to indicate the reason for the selection of the different resistances which are used.

The line is banked up to a resistance of 350 ohms so that all lines within a radius of sixteen miles of the central station may be accommodated (22 ohms per mile being taken as the maximum resistance of wires running into large centres from places which would be worked from a common battery). If the resistance per mile is less than this amount greater distances can, of course, be covered, as the system can stand considerable line leakage and capacity.

In order to keep the difference of potential across the polarised sounder at the out station constant when the key there is depressed, the resistance P (see diagram **3**) for the meaning of the symbols) must obviously equal $L + \frac{bG}{2b + G}$ when the key at the central station is depressed. It now only remains to determine the value of β, the key at the central station still being depressed. The work is rather laborious, but the relation which must hold, in order that the spacing and marking currents in G for a given voltage should be equal, is best expressed as—

$$\frac{a-\beta}{bG + a\,(2b + G)} = \frac{\beta-a_1}{bG + a_1\,(2b + G)}.$$

From this β should equal 1200 ohms; a standard coil of 1250 ohms is used.

When the key at the central station is not depressed the resistances that have just been determined must still apply.

By Kirchhoff's laws,

$$-bx + 2by + Gz = 0$$
$$\beta x - (\beta + a)\,y + (G + \beta + a)\,z = 0$$
$$by + (y - z)\,a = E.$$

therefore,

$$\frac{x}{2b\,(G + a + \beta) + G\,(a + \beta)} = \frac{y}{G\beta + b\,(G + a + \beta)} = \frac{z}{b\,(a + \beta) - 2b\,\beta}$$

From which

$$y = \left\{G\beta + b\,(G + a + \beta)\right\}\frac{E}{D}$$
$$z = \left\{b\,(a - \beta)\right\}\frac{E}{D}$$
$$y - z = \left\{G\,(b + \beta) + 2b\beta\right\}\frac{E}{D}$$

and $D = G\,(a + b)\,(b + \beta) + b^2\,(a + \beta) + 2ab\beta$.

From these equations the current in the relay and in the line may be calculated.

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Again, when the key at the out station is depressed the currents in the various branches at the central station will change. We have, as before,

$$-bi + 2bj + Gz = o$$
$$a_1 i - (a_1+\beta)j + (G + a_1 + \beta)z = o$$
$$b(i-j) + a_1(i - j + z) = E$$

therefore,

$$\frac{i}{2b(G + a_1 + \beta) + G(a_1 + \beta)} = \frac{j}{Ga_1 + b(G + a_1 + \beta)} = \frac{z}{b(a_1 + \beta) - 2ba},$$

and therefore,

$$i = \left\{2b(G + a_1 + \beta) + G(a_1 + \beta)\right\}\frac{E}{D_1}$$
$$j = \left\{Ga_1 + b(G + a_1 + \beta)\right\}\frac{E}{D_1}$$
$$z = \left\{b(\beta - a_1)\right\}\frac{E}{D_1}$$
$$i - j + z = \left\{G(b + \beta) + 2b\beta\right\}\frac{E}{D_1}$$

and $D_1 = G(a_1 + b)(b + \beta) + b^2(a_1 + \beta) + 2ba_1\beta$.

In order that the difference of potential across the polarised sounder at the out station should not change, $i-j+z$ must equal 2 $(y-z)$, and equating the two expressions for these, substituting for a and a_1 we finally get—

$$P = L + \frac{\{G(b + \beta) + b\beta\}b}{(G + b)(b + \beta) + b\beta}.$$

The result is somewhat curious, as it means that whether the resistance β is joined to earth or to the positive pole of the battery the difference of potential across the polarised sounder at the out station remains constant in any position of the key there for any given position of the resistance β, and this fact affords an easy means of calculating the resistance of P.

It is not possible by any combination of resistances to keep the magnetic induction in the relay at the central station constant in strength for all positions of the key at that station, which may be easily seen by equating the expression for (z), to twice the difference between the currents in the relay when the key is depressed. The difference in the magnetic induction when the key is up or down may, however, be made as small as possible by reducing the value of b, and although a maximum current is obtained in G when

$$b = \sqrt{\frac{Ga\beta}{G + a + \beta}}.$$

yet the value of b is made 1000 ohms, so that a sufficient change is made in the line current to actuate the polarised sounder at the out station when the key is depressed.

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THE TYPEWRITER AND PIECE-WORK IN TELEGRAPHY.

By DONALD MURRAY, M.A.(Sydney).

IF some magic carpet suddenly transported a British telegraph engineer into a large New York telegraph office he would at first be dazed by the extraordinary clatter of the sounders, which are tuned up to make about four times as much noise as the British variety. The next sound to catch his attention would be the click of typewriters. He would see typewriters by dozens and scores, every operator with a typewriter, and all telegrams being typewritten. The pen used to be mightier than the sword, but there are no swords and very few pens in American telegraph offices nowadays. Every operator has his "mill," as the typewriter is familiarly called. The telegraph companies do not supply the typewriters. Each man has to furnish his own machine, and a telegraph operator without a "mill" has now no chance of employment in any of the large cities of America. The typewriter manufacturing companies make special efforts to cater for the custom of operators, and dealers in second-hand machines do an immense business amongst the telegraph fraternity. When an American operator is out of work and hard up he sells his typewriter to one of these agencies, or if he gets a job he hires a "mill" until such time as he is in a position to buy it.

The use of the typewriter as an ally of the morse key and sounder is a very old story in the United States, but it was not till about 1890 that it began to come into general use, and now an operator in America is as helpless without his "mill" as a cowboy without his gun.

So far as the telegraph companies are concerned the direct pecuniary saving through the employment of the typewriter has been small, but the companies have derived various indirect benefits. The public have gained by getting clear typewritten telegrams, and the competition between the two great telegraph companies has made the use of the typewriter absolutely unavoidable. The typewriter also has resulted in considerable speeding up of telegraph work. The great gainers from the use of the typewriter, however, have been the operators themselves, and it is no doubt for that reason that the cost of providing typewriters has fallen on the operators. The increase of output by the use of a typewriter compared with a pen is nothing like so great as is generally supposed, and the real advantage of the typewriter does not lie so much in increased output as in rescue from pen slavery. The nervous strain and muscular drudgery of rapid writing is enormous compared with

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the same work done on a typewriter. When using the pen or pencil one group of muscles and one set of nerves have to perform a very complicated series of motions for each letter. With the typewriter, on the other hand, one simple motion of one finger is sufficient, and even this great reduction of muscular and nervous strain is again reduced eightfold by spreading the work over all the eight fingers of both hands. It is this complete release from pen servitude that has made the typewriter such a boon to telegraph operators in America, and it is surprising that telegraph operators in this country have not long ago recognised the "mill" as a friend and helper.

Roughly speaking, in America the effect of the typewriter has been to lighten the work of the receiving operator and to increase his efficiency. Operators who ranked only as second class on account of slowness or defects of penmanship have become first class. Formerly the sending operator on the morse key could make the receiving operator "sit up." With the advent of the typewriter, however, the position is now reversed, and the receiver can take with ease all that the finest star operator can send. In America this has led to the extensive use of word contractions, and these have been standardised and published in a manual known as *Phillips Code*. All good American operators use this code, and, although the sending operator can no longer make the receiving operator "sit up," the former can at least keep the latter busy even on the typewriter. Of course, contractions are employed by telegraph operators all over the world, but not to anything like the same extent as in America. Here, for instance, is an example of the way in which Press messages are sent on the Morse key in the United States :—

Mems o cx Cgs rptg und cv cmns o eno cap wo krp xgn ifo thr adhts wi cmb aga ay emt to t crpns, bt cujx es dtmd efo qpt peo f sq stas wi efy dmz ay osn.	Members of Congress representing under cover combinations of enormous capital who corrupt legislation in favor of their adherents will combine against any embarrassment to the corporations, but courageous and determined effort on the part of the people of the separate states will effectually demoralize any opposition.

In the first column is given the coded message, and in the second column the translation as it is typewritten by the receiving operator direct from the sounder. Of course, operators have to brush away the cobwebs from their intellects to do work of this kind, but they are very well paid for it. An American operator, writing on this subject, says:—"With an intelligent sender matter of this sort can be transmitted at the rate of fifty-five words per minute with but very little effort, and, at the same time, with reduction of the strain on the receiver to a minimum."

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As regards Press messages, the effect of this combination of "code" sending and typewriter receiving has been remarkable. It is now not a rare thing for two first-class Press operators in America, one sending "code" and one receiving on the typewriter, to handle 20,000 words of press in one night. The record is said to have been 24,000 words transmitted and received by two men in eight hours. That is roughly about twelve columns of the London *Times*, an astonishing feat of endurance to anyone practically acquainted with such work.

The code contractions for common phrases are works of art. Here are a few examples:—

Fapib—Filed a petition in bankruptcy.
Dbf—Destroyed by fire.
Cats—Created a tremendous sensation.
Ckx—Committed suicide.
Asaph—A speculative demand with prices higher.
Bsql—Business small and quotations lower.
Herdam—Heavy receipts depress the market.
Utc—Under the circumstances.

I do not know what the rule is now, but a few years ago the telegraph companies encouraged the use of code for press work, and strictly forbade but winked at its use in handling commercial messages. As both the Western Union and the Postal Telegraph Companies have a large number of "bonus" circuits on which the operators are paid a halfpenny per message for all that they send over about 300 per day, the operators naturally code wherever they can, and some of the records made with the Morse key, code, sounder and "mill" are surprising, especially when it is borne in mind that in American messages only the text is paid for, the address going free, and that, therefore, American messages average about thirty words compared with the British twenty; also that about half of American messages are code messages in the ordinary sense, and that, therefore, the Phillips contractions are not applicable to them. Under these circumstances a speed of 40 messages an hour is quite ordinary, a speed of 60 messages an hour is regarded as very good, and 80 messages an hour have been transmitted for hours at a time.

In Canada and other new countries the typewriter is also being quite freely used in telegraphy. On the Continent of Europe there is but little scope for it, as the bulk of the traffic is handled by the Hughes, but in Russia the large telegraph offices employ dozens of typewriter girls to type up messages from the received Wheatstone slip, the Wheatstone being extensively used in Russia, owing to the immense distances covered by the telegraph network.

In conclusion, a paragraph in regard to the bonus system and typewriters from a letter written by Mr. Minor M. Davis, Chief

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Engineer of the Postal Telegraph-Cable Company in New York, may be of interest. It is as follows:—

"Replying to your questions about the bonus, or piece-work, system:—A minimum, intended to represent a good day's work, is determined upon by observation. The typewriter enables a capable receiver to comfortably transcribe 'anything that comes clear,' and the stress of fast work has been shifted to the sender by that machine. Observation, checked by experience, shows that between 8 and 5.30 a good man will handle about 300 on a New York-Boston circuit, 325 on a New York-Philadelphia circuit, 280 on a New York-Chicago, and so on, the allowances being made for more interruptions to the longer circuits. There is no science in the proportions; as stated above the minimum is arbitrarily determined after observation. With the above figures to be reached between 8 and 5.30, each operator on these piece-work circuits is allowed one cent per message for each message handled in excess of the minimum, or if he prefers to cease work when he reaches the minimum he is excused and paid his regular salary for the full day. There are comparatively few circuits that can be operated in this manner (we have only about twenty-five of them). The increase in speed is considerable. It is not uncommon for an operator to handle a hundred messages more than the minimum, and sometimes operators handle 500 messages in a day. I have known one or two cases where 600 have been handled. Operators are not required to work at these very high speeds; but usually they are applicants for these circuits. It takes 'good men' to work them, and operators like to be known as capable of the work. They are required to do good, clear, accurate work, and they are held to the usual accountability for errors. Abbreviating the text (coding) is prohibited. The bonus system, like every other, fails to manage itself. There is temptation to do this, that, and the other thing that cannot be permitted; but, instead of sitting at a 'busted' wire perfectly content to do nothing, the bonus operator co-operates with the chief in making stops as few and short as possible. With proper supervision, and provided that the operator gets regular pay (minimum) that insures to him a fair income, I believe the system to be a good one for both employee and employer. Tendencies to kill the goose by overworking should be discouraged. This Company certainly does not ask or wish its employees to overwork. There was no special trouble in introducing the typewriter. It makes the receiver's work easier. It brings in a few errors of its own, but, on the whole, is beneficial to the service. It has probably added something to the speed—no one knows how much; but, in message work, the chief gain is probably due to the fact that operators who are not expert with the pen can readily 'keep up' when they use a machine."

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THE TELEPHONING OF LONDON.

By W. NOBLE, A.M.I.E.E.

(*Superintending Engineer, Metropolitan Central District.*)

THE telephoning of London by the Post Office is now an old story, comparatively speaking, yet the connection between that great work and the *Post Office Electrical Engineers' Journal* is so obvious as to afford ample justification for a reference to it in these pages; for, had there been no telephoning of London by the Post Office, the present large engineering body in London would not have been brought into existence—(many, perhaps the majority, of the "Metropolitan Centre" would now be enjoying a life of ease in the Provinces!)—without that large body there would have been no Post Office Institution of Electrical Engineers, and without the Institution there could have been no magazine. Since, therefore, this JOURNAL owes its birth to the telephoning of London, it is only fitting that an outline of the work from its inception should appear in its early issues.

The Survey.—The initial step was the survey of what was known as the metropolitan area—no small task, seeing that the area in question embraced about 640 square miles. Briefly, the procedure was as follows:—

Number of Subscribers.—A large scale map indicated the location of the then existing subscribers of the National Telephone Company. This map was divided into suitable square sections, their size depending on the density of the subscribers as indicated by dots, and the number in each section was counted. Every street was traversed, and the number of new subscribers that might reasonably be expected within a period of, say, seven years was estimated, regard being had to the class of buildings in the streets, the additional provision varying from 10 per cent. to 100 per cent. or more, of the existing subscribers. The survey of the metropolitan area was carried out satisfactorily on the whole, but as showing the difficulty of estimating the growth in London, one instance that came under my notice, typical of not a few, will serve to illustrate the extraordinary development which may take place in London in a very short period. In a small city area the provision estimated as necessary to cover a period of years was for 63 subscribers: to-day there are considerably over 400 subscribers, and the number is rapidly increasing. Certain small houses that once stood in different parts of the area have been superseded by palatial buildings, four of which alone represent a total of 2,035 rooms, let mostly to influential and wealthy firms.

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Main Routes.—The survey included the selection of main routes for the conduits. The principal thoroughfares generally were selected as being not only the best "feeders" for the side-streets, but as ensuring the shortest mileage from the exchanges to the busiest areas to be served. Economy in the length of the main cables was an important factor.

Number of Conduits and Sites for Manholes.—Embraced in the survey was the calculation of the number of conduits to be constructed so as to cover a period of years; and the selection of the sites for manholes. These sites were usually selected at or near the point of junction of two or more streets and the main thoroughfare, in order to simplify and cheapen distribution.

Let it be remembered that London was the first city in which a purely underground system of telephone distribution was laid down, and the work was therefore pioneer work.

Conduits.—To the form of conduit that was to be used much consideration was given. For heavy routes the use of cast-iron pipes was out of the question: their cost was great, and the space required for spigot and socket pipes could not be found on the congested routes. The Post Office adopted, for the first time, the now well-known octagonal earthenware duct, which has proved eminently satisfactory, and has been largely adopted by other bodies, the London County Council, for example, having used it for its extensive underground works for electric tramways. In 1900 the current prices made it economical to use ducts when six or more conduits were required; for a smaller number there was economy in using pipes. Ducts have the further advantage, apart from the question of cost, that they are less liable to damage by excavators than are cast-iron pipes, on account of their being encased in concrete 4 to 6 inches thick. Indeed, a spare cast-iron pipe may be damaged without the fact being discovered until a cable has to be drawn in.

Another point in favour of the earthenware duct not to be overlooked by "prime cost" economists, is that its life is to all intents and purposes unlimited, that of a pipe being limited and varying with the nature of the soil in which it is laid.

The employment of multiple ducts was considered, but it was recognised that the advantage lay with the single duct, in that it lends itself to a variation in grouping when obstructions are met with, and "folding over" has to be resorted to. Perhaps the most interesting case of folding over took place in Queen Victoria Street, and deserves to be described. From the front of the General Post Office (South) a group of 90 ducts in six tiers of 15, resolves itself at three different points, a few yards apart, into three sets of 3¼ in. cast-iron pipes grouped in six tiers of five. These three groups fold over into one nest of two layers each of 45 pipes, which again split up into

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three sets of 30 ducts in six tiers of five. Later the three sets of six tiers resolve themselves into one nest of nine tiers of 10 ducts; and this group in turn becomes one of six tiers of 15 ducts each. Had multiple ducts been used a jointing chamber would have been required at each point of re-grouping.

Connection between earthenware ducts and cast-iron pipes is made by means of cast-iron coupling pieces of two classes, one having a socket, and the other a spigot end to fit the pipes, the other end in both classes being octagonal and of similar dimensions to the earthenware duct.

Jointing Chambers.—Jointing chambers are divided into two main classes, manholes and boxes. Prior to 1900 manholes were non-existent in the Post Office service, the largest chambers being double junction boxes measuring about 4 ft. by 2 ft. To-day, in the Central Metropolitan District alone, there are no fewer than 602 manholes, varying in size from about 4 ft. long by 3 ft. wide and 5 ft. deep to 8 ft. long by 7 ft. wide and 6 ft. deep, to say nothing of a few special ones of much larger capacity.

Means had to be devised to meet the requirements of roadways and footways, but it is needless to describe here the various types designed; a brief description of the general principles of construction will suffice.

The roadway manholes are of 14-inch brickwork on a well-prepared foundation of 9-inch Portland cement concrete, in which are embedded stout wrought-iron ring-bolts for use in manipulating the cabling tackle. The roofs are of rolled steel joists and half-inch boiler plate covered with Portland cement concrete, the whole being waterproofed with three-quarter-inch mastic asphalte. The manhole frames and covers compare favourably in the matter of strength with those used by other bodies.

Footway manholes have walls of 9-inch brickwork on a 6-inch concrete foundation, and a roof of York stone resting on steel joists.

The bricks used in the construction of both classes of manholes are of the highest grade red wire-cuts, undoubtedly the best class of brick for this purpose, being capable of resisting a great tensile strain and having a very low power of absorption.

There can be no doubt that the Post Office manholes are the most substantially built structures used in any class of underground work.

Nothing need be said about boxes beyond this: that the telephoning of London brought about the introduction of the channel frame form, as well as an increase in the number of types of boxes.

Specifications and Drawings.—The classes of conduits and the type of manholes and boxes once determined, there remained the preparation of specifications and drawings. This was no light task,

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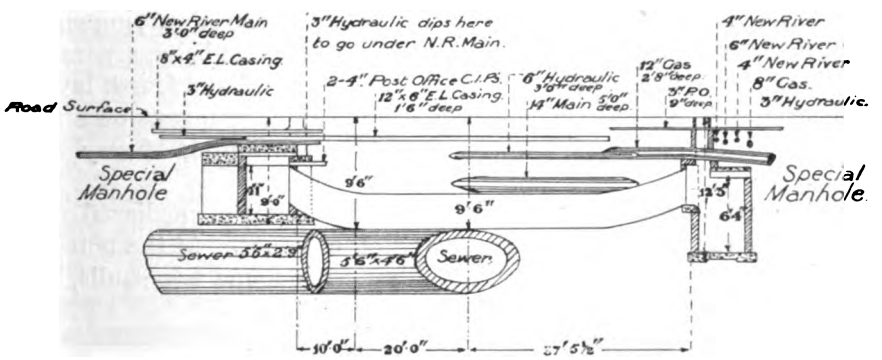
as will be realised by those who are now acquainted with the specifications for underground works, and the varied auxiliary plant, as well as with the numerous drawings pertaining thereto. A detailed examination of Specification Forms Nos. 18 and 74 alone will make this abundantly clear. That it was done thoroughly is evidenced by the fact that the forms have been amended in no essential detail, and that Contractors generally regard them as the most complete and binding forms to which they have to tender.

Construction.—It was recognised, prior to the commencement of street operations, that great difficulties would be met with in laying heavy duct-lines in the London streets which, it was well known, were already congested with mains—water, gas, electric light, and hydraulic. Those only who took an active part in the work can fully realise the enormous difficulties that were actually encountered and overcome. In not a few cases portions of trenches had to be kept open for a month whilst diversions of existing mains and



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alterations to sewers had to be effected in order to admit of the laying of the Department's ducts in a straight line.

There exist no means of conveying the faintest conception of the obstructions encountered, but some idéa may be formed from I, which depicts the obstructions met with in a street where sixty-four ducts had to be laid. On the ground being opened, those not responsible for seeing the work through might have been pardoned for declaring the task an impossible one, but it was accomplished as well as many similar tasks.

In the numerous and extensive excavations many interesting relics were unearthed. Space permits of reference to one only, but it is of most general interest. A duct-line along London Wall, from Moorgate Street to Bishopsgate, was, for a portion of its route, constructed in the centre of the lower portion of the old Roman wall.

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The trench, which was 2 ft. 6 ins. wide and about 9 ft. in depth, was cut through the Roman masonry.

The exposure of the wall aroused the keen interest of the Society of Antiquaries, who applied to the Post Office for permission to deepen an excavation in order to ascertain how the wall had been constructed by the Romans across the stream, known later as the Walbrook, recorded as having flowed under the wall near the site of the operations. The requisite permission was obtained, and the Society representative who had the matter in hand reported *inter alia* that, in connection with the work, " . . . the Post Office officials from the first evinced a very sympathetic interest. This is worthy of record, as in former years authorities have been by no means favourable to inquiries of the kind we (the Society of Antiquaries) had undertaken."

To the Society I am indebted for an electrotype of **2**, showing an elevation of the wall and a section of the shaft sunk near Circus Place and opposite Throgmorton Avenue.

Briefly, the wall consists of layers of ragstones of varying sizes, the first and second and the second and third layers being separated by bonding courses of tiles of red clay. The third and fourth layers are separated by a red sandstone plinth, which in turn rests on a few courses of rough rubble ragstone, with a final footing of clay and flint.

Interesting relics came to light, *e.g.* fragments of mediæval and Roman pottery, and several skulls and other bones. At the bottom, resting in the sand overlying the ballast, were found two skulls, the one shown in **2** being in almost perfect condition.

(To be continued.)

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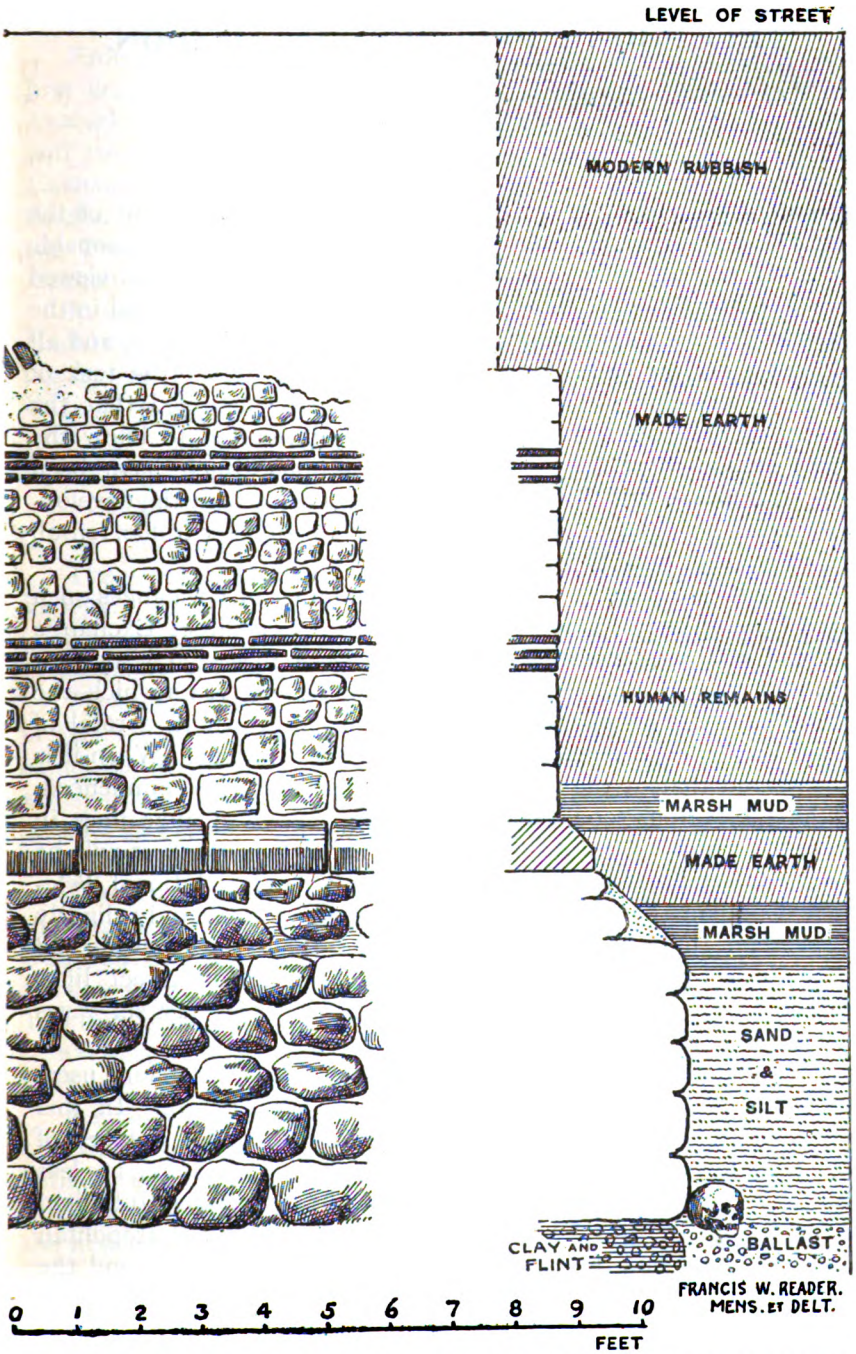

2.—Section of Shaft cut through Old Roman Wall near Throgmorton Avenue, London.

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TELEPHONE PROGRESS IN LONDON.

By G. F. PRESTON, M.I.E.E.
(*General Manager, Post Office London Telephone Service.*)

To furnish a comprehensive account of the development of the Post Office London Telephone Service in an article of reasonable length is not an easy matter, as this development may be viewed from so many different standpoints and the mass of material in the shape of figures, all seemingly too important to be omitted, and all calling for at least a few words of explanation, makes the task of selection very difficult. It has, however, been assumed that the readers of the JOURNAL will be principally interested to know the actual number of Exchange lines and stations which have been brought into use, and this article, therefore, deals with the development from this point of view only, leaving questions of traffic, rental, etc., to be dealt with at a later date.

The table on page 30 shows the total number of Exchanges open in the London area, together with the number of direct Exchange lines and stations * working at the 31st December each year from 1902 to 1907. It will be seen that during the six years which the service has been in operation the system has grown to a total of 34,100 Exchange circuits, and 46,355 extension stations. When it is remembered that at the time the Department's service commenced, on the 1st March, 1902, there were only 25,000 Exchange lines in the London area as the result of over twenty years' work, it will be seen that very great strides have been made. The National Telephone Company have added to their system at a rate only slightly slower than that of the Department, and they have now 53,928 direct lines working: this makes a total of 88,028 direct lines working in the Metropolitan area, so that during the last six years the number has increased three and a half times.

Much has recently been made of the objection of telephone users to the abolition of the flat or Unlimited Service rate. In this connection it is interesting to know that, of the total number of Exchange lines connected with the P.O. London system, no less than 30,245 are Message Rate circuits, only 3855 being Unlimited Service lines. It will thus be seen that, since the P.O. Metropolitan subscribers have had the choice between Unlimited Service and the Message Rate, 90 per cent. have elected for the latter, and it is, therefore, extremely difficult to believe that there is any such

* Some misapprehension exists as to the exact meaning of the term Exchange Station. It may be defined as any speaking point (main or extension instrument) at which facilities for communication over the Exchange system can be obtained.

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widespread objection to the measured rate as its opponents have endeavoured to show.

From the table above referred to it will be seen that during the first year, 1902, seven Exchanges were opened, in 1903 two more were added, in 1904 a further two, in 1905 three, in 1906 one Exchange and two Exchange centres, and in 1907 three Exchanges and five Exchange centres, making a total of eighteen Exchanges and eight Exchange centres. The table also includes the lines working on the Treasury Exchange, and the direct lines rented to the trunk Exchange.

It will, perhaps, be of interest to give the average user of the Exchange lines connected to the principal Exchanges. The following figures are from records taken at dates approximate to the 31st December, 1907 :

Average Number of Calls per Line per Day.

Central	6·81.	Mayfair	4·5.
Western	4·0.	Hampstead	3·1.
Victoria	4·8.	Hornsey	4·0.

The smaller Exchanges range from 1·8 the lowest, to 2·9 the highest.

The average is based on the figures for the total demands made —not the total effective calls.

Trunk Exchange.—The trunk Exchange was transferred to the G.P.O. (South) on the 3rd February, 1904. The growth has been rapid, and there are now twice as many trunk circuits working, and nearly double the number of local call wires, junctions, and record circuits as existed at the time of the transfer. The number of calls dealt with daily has increased two and a half times.

The introduction of call wire working on trunk lines has been the most important change in practice, the carrying capacity of the trunk circuits having been very greatly increased thereby. There are now twenty telegraph and two telephone trunk call wires working. The results have been most satisfactory, the carrying power of the trunk lines affected having been increased from thirty minutes to forty-two minutes paid time per hour.

A change in the method of record working has also been carried out, whereby it has been possible to secure direct record working with all subscribers in the London area, with equal distribution of work between the various record operators. It is also possible with the new method to arrange for the "record" staff to be increased or decreased in direct proportion with the number of calls received.*

* Another improvement is the abolition of Trunk Transfer working and the provision of direct lines connecting each position with every other position in the Exchange.

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Table showing Annual Increases of Lines and Stations P.O. London Telephone Service.

EXCHANGE.	Date of opening.	31st December.											
		1902		1903		1904		1905		1906		1907	
		Direct Lines.	Stations.	Direct Lines.	Stations.	Direct Lines.	Stations.	Direct Lines.	Stations.	Direct Lines.	Stations.	Direct Lines.	Stations.
Central	1/3/02	4,167	4,859	7,587	9,720	9,995	13,315	12,155	16,999	13,741	19,862	14,696	22,293
Putney	20/5/02	168	183	336	362	474	521	637	695	804	896	926	1,036
Kingston	20/5/02	175	187	288	316	403	446	517	580	668	752	783	902
Western	5/8/02	378	394	1,144	1,243	1,710	1,897	2,395	2,664	3,081	3,464	3,697	4,214
Wimbledon	6/8/02	109	117	215	238	308	348	424	471	564	631	667	747
Victoria	12/8/02	368	442	850	1,039	1,251	1,615	1,707	2,310	2,109	2,890	2,451	4,266
Richmond	7/11/02	94	112	245	283	358	419	524	602	605	693	695	799
Chiswick	3/6/03	...	...	178	180	360	393	500	553	630	708	709	807
Mayfair	20/10/03	...	...	725	794	1,520	1,787	2,359	2,924	3,006	3,892	3,548	4,707
Croydon	26/1/04	...	...	...	...	181	203	355	390	468	514	553	600
Hampstead	27/7/04	...	...	...	...	883	968	1,797	1,971	2,556	2,808	2,995	3,306
Epsom	29/5/05	...	...	...	...	...	...	63	66	112	116	145	153
Ealing	5/6/05	...	...	...	...	...	...	303	345	471	526	579	640
Sutton	9/6/05	...	...	...	...	...	...	65	69	225	234	345	362
Hounslow	1/7/06	...	...	...	...	...	...	...	...	73	87	101	120
Harrow	10/10/06	...	...	...	...	...	...	...	...	91	100	158	185
Wembley	18/10/06	...	...	...	...	...	...	...	...	23	29	41	62
Malden	11/2/07	...	...	...	...	...	...	...	...	...	...	25	27
Esher	13/2/07	...	...	...	...	...	...	...	...	...	...	62	65
Willesden	26/2/07	...	...	...	...	...	...	...	...	...	...	232	250
Finchley	28/3/07	...	...	...	...	...	...	...	...	...	...	22	23
Southall	11/9/07	...	...	...	...	...	...	...	...	...	...	7	9
Hornsey	7/11/07	...	...	...	...	...	...	...	...	...	...	287	306
Barnet	14/11/07	...	...	...	...	...	...	...	...	...	...	13	14
City	26/11/07	...	...	...	...	...	...	...	...	...	...	129	170
Treasury	...	...	...	105	126	113	142	118	155	120	157	136	170
Trunk	...	...	...	...	...	105	127	103	125	100	124	98	122
Total	...	5,459	6,294	11,673	14,301	17,661	22,181	24,022	30,919	29,447	38,483	34,100	46,355

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COMMON BATTERY TELEPHONE TRANSMISSION SYSTEMS, AND SOME METHODS OF THEIR APPLICATION BY THE POST OFFICE.

By M. Ramsay.

The number of common battery circuit arrangements differing more or less from one another that have been devised is very large, but only three fundamentally different transmission systems have

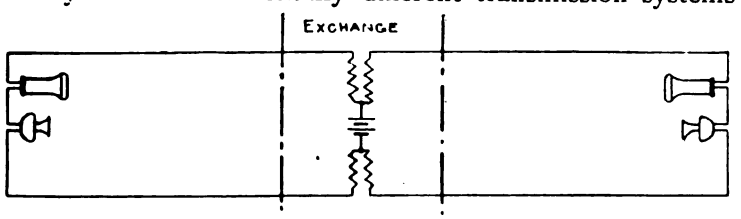

Fig 1 Hayes Common Battery System

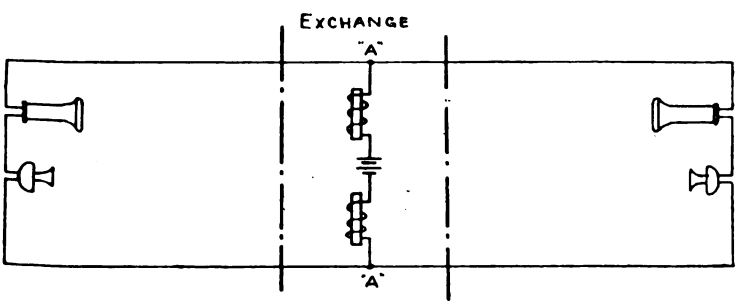

Fig 2. Stone Common Battery System

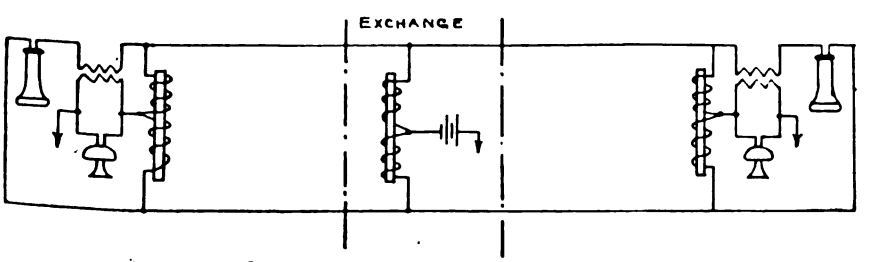

Fig 3 Dean Common Battery System

been proposed, and, so far as the writer is aware, only two of these are in operation.

In the year 1892, Hayes and Stone devised the systems shown in 1 and 2 respectively; the third, known as the Dean system, is shown in 3. The essential feature of the Hayes system is the use of a repeating coil (a transformer, in this case possessing a trans-

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formation factor of unity) with the common battery in the centre of its windings.

When two telephone circuits are connected together by such a combination, the voice currents are simply repeated inductively from one to the other by the transformer, that circuit whose transmitter is being spoken into acting as the primary for the time being, and the other, in whose receiver the speech is being reproduced, acting as the secondary of the system.

The characteristic of the Stone system is the interpolation of impeding coils between the common battery and the lines. When two circuits on this system are connected together, the variable currents produced in one of them by speaking into its transmitter, develops a correspondingly variable pressure between the points "A" and "B" (see **2**), and these two points being the terminals of the second circuit, a variable E.M.F. is impressed upon the latter, with the result that a correspondingly variable current passes through the second telephone.

In the Hayes and Stone systems current is fed to the transmitters round the loop, in which respect both differ from the Dean system, whose characteristic is the supply of the primary speaking current to the transmitters over the line wires in multiple, the earth being used as a return. Each transmitter in the case of the Dean system is placed in the earthed circuit in multiple with the primary winding of an induction coil, whose secondary is connected up, to operate in the loop circuit. When transmitting, current flows out from the exchange, and, dividing between the transmitter and the induction coil primary, passes to earth. Any variation of the resistance of the transmitter causes a variation of the current strength in the primary, and this varying current acting upon the secondary winding impresses a variable E.M.F. upon the line circuit.

It is obvious that the grade of transmission furnished by any system will depend upon the values of the various factors involved. In the Hayes circuit, for instance, the value of the E.M.F. impressed upon the receiving circuit will depend largely upon the battery voltage, upon the number of turns, resistance of the windings, and the conformation of the repeating coil, upon the resistance of the primary line circuit (its capacity may be ignored unless the circuit is comparatively long), and upon the range of variation of the transmitter resistance, as well as the arrangement and nature of the various parts making up the complete transmitting set.

4 indicates an application of the Hayes system. The diagram shows the typical cord circuit installed by the Western Electric Company in the Department's large common battery exchanges. The supply voltage is 22, but it may be 26 or more when the current is taken from the generators direct.

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The repeating coil has four windings, two of which act as primary and two as secondary, and each of the four has 2150 turns and a resistance of 38 ohms. When this repeating coil is used with a battery of 22 volts and with telephones of the standard type supplied by the Western Electric Company, commercial speech is possible over a length of approximately forty miles of standard cable with 300 ohms line resistance in the transmitting circuit. A result about 5 per cent. better is obtained when the repeating coil is substituted by one of the 25 C. type, whose four windings have each 1000 turns and 23 ohms resistance. The first-mentioned coil is built round a straight core, while the 25 C. type is constructed round a core whose axis is a circle, and it is probably to this difference of conformation and the lower resistance that the advantage of the 25 C. type is due.

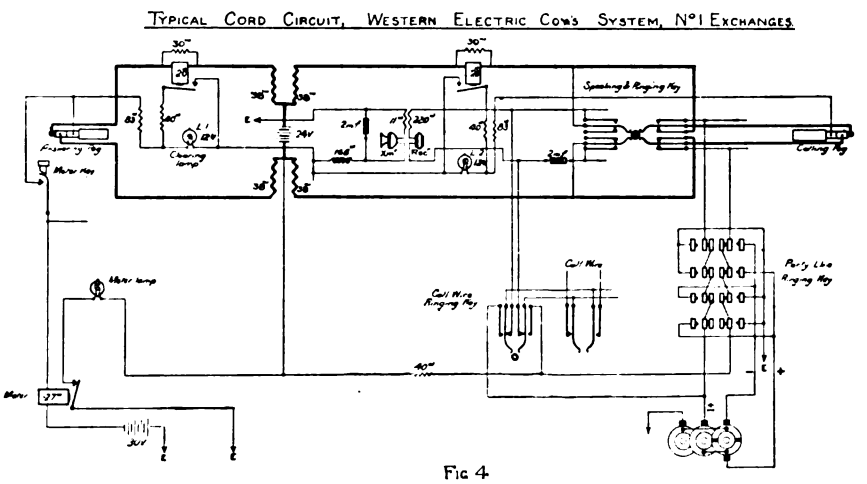
TYPICAL CORD CIRCUIT, WESTERN ELECTRIC CO'S SYSTEM, N°1 EXCHANGES
Speaking & Ringing Key
Calling Key
Call Wire
Call Wire Ringing Key
Party Line Ringing Key

FIG 4

The effect of line resistance upon the transmission values is indicated by the curves shown in 5 and 6, which are reproduced here from the paper on "Telephone Transmission" read to the Institution by Mr. J. G. Hill.

The circuit shown in 7 is an application of the Stone system. This, and several other kindred circuits, are used by the Post Office on Branch Exchange Switchboards for communication between extensions. Their use is limited to this purpose because of a defect possessed by the system which renders its use objectionable in public exchanges. In the case of the Hayes circuit, just considered, the conditions for the supply of current to the transmitter on any circuit are constant, provided the voltage between the distributing bus bars does not vary. It is not so in the case of the Stone system, as the current supplied to a given transmitter is determined, not only by the battery voltage and the various resistances in the trans-

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CURVE SHOWING HOW THE SPECIAL LIMIT VARIES WITH THE RESISTANCE IN THE TRANSMITTING CIRCUIT.

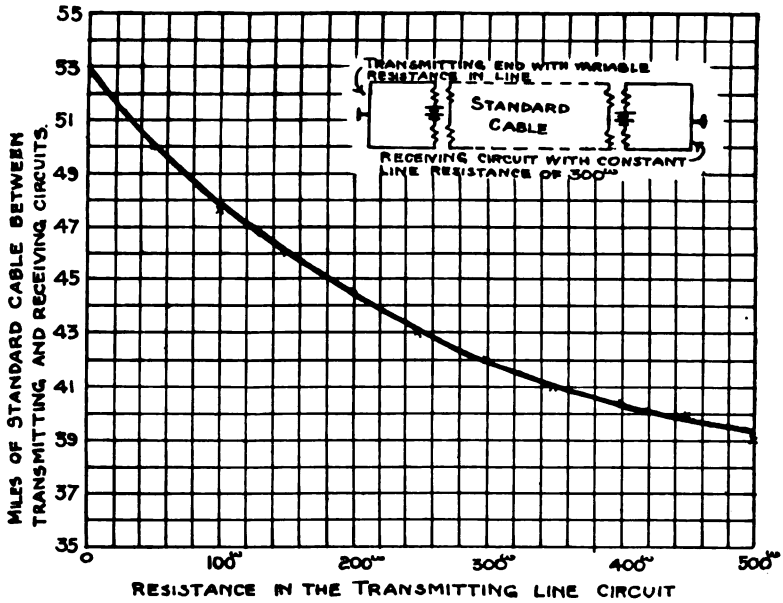

FIG. 5.

CURVE SHOWING HOW THE SPEECH LIMIT VARIES WITH THE LINE RESISTANCE IN THE RECEIVING CIRCUIT.

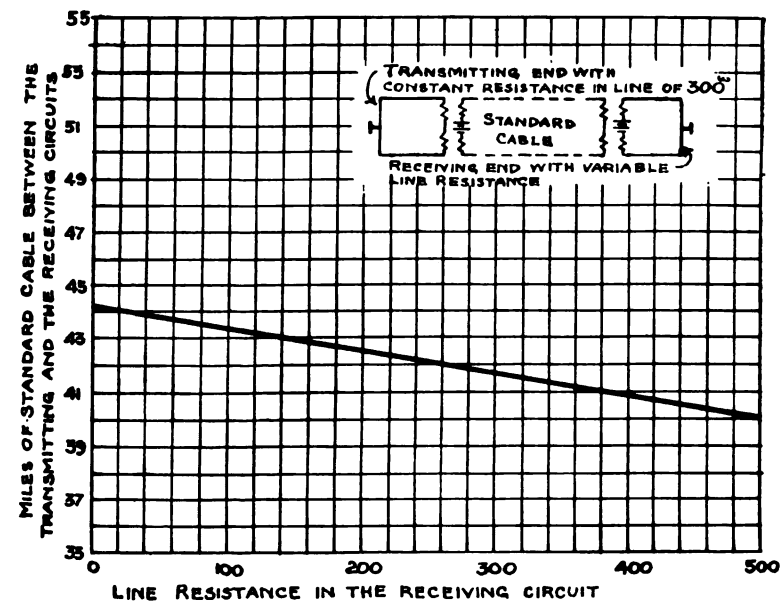

FIG. 6.

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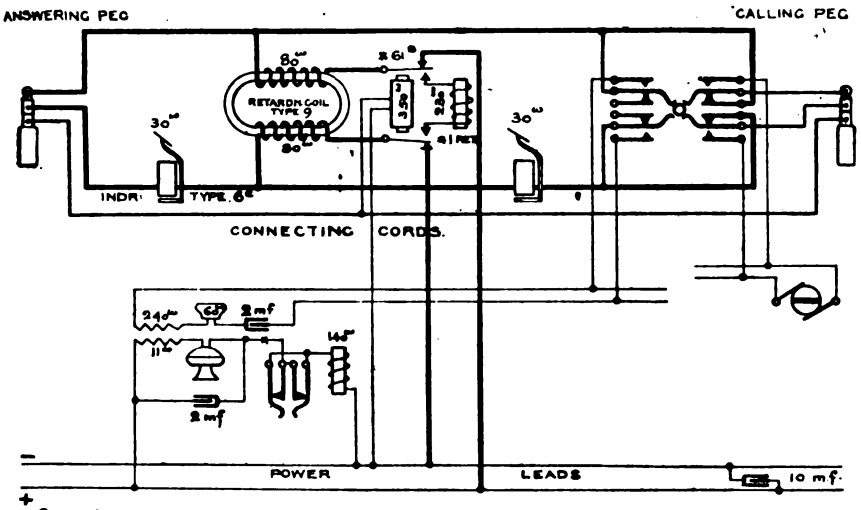

CORD CIRCUIT USED ON LARGE PRIVATE BRANCH EXCHANGE SWITCHBOARDS.

FIG. 7

TYPICAL CORD CIRCUIT, BRITISH INSULATED COS SYSTEM.

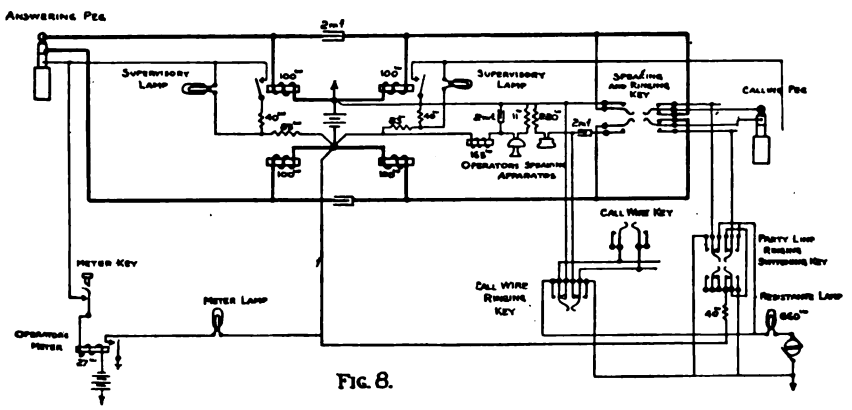

FIG. 8.

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mitter's own line circuit, but also by the resistance of the other line to which it is temporarily connected. As a consequence of this variation of supply conditions, the Stone system in its pure form is not employed where the highest grade of transmission is required.

The defect is overcome by the employment of condensers and two sets of impeding coils, and circuits embodying such a method are indicated in **8**, **9**, and **10**.

In **8** is depicted the typical cord circuit of the British Insulated and Helsby Cables, Ltd., employed by the Post Office at Cardiff and elsewhere. Certain of its features, viz. the signalling, metering and operators' circuits, are substantially the same as those of the Western Electric Co.'s system. The supervisory relays act as the impeding coils between the battery and the tip or "A" side of the lines, while the retardation coils have a similar function between the battery and the "B" or ring side of the circuits.

The grade of transmission obtained with this combination is very similar to that furnished by the Western Electric Co.'s circuit.

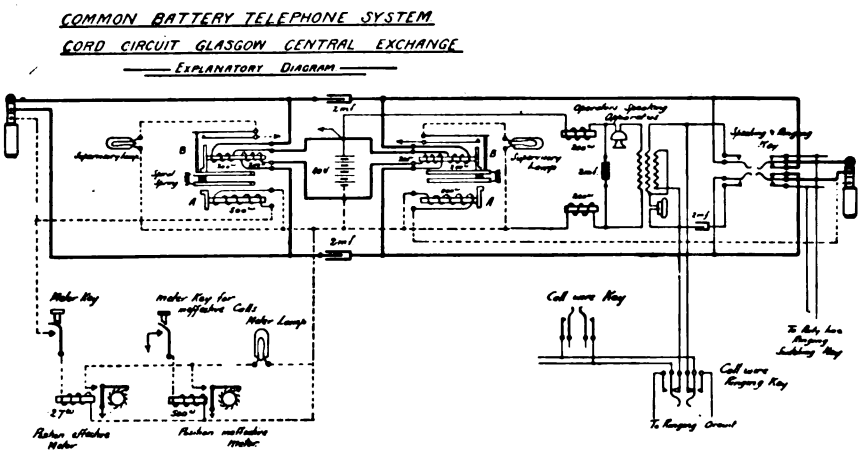

FIG. 9

The variation of resistance in the transmitting circuit gives a curve somewhat flatter than the one shown in **5**. With low resistance in the transmitting circuit the Western Electric arrangement has the advantage, but with 200ω and upwards in the line the two systems are equal. As regards reception, with low resistance in the receiving circuit the advantage is with the Helsby system, but, as in the case of transmission, with line resistances of 300 ohms and upwards, the systems are equal.

A circuit of a similar transmission type, but whose details differ considerably from those of the circuits already considered, is that shown in **9**. The features of this circuit, from a transmission standpoint, are the high voltage of the battery and the comparatively

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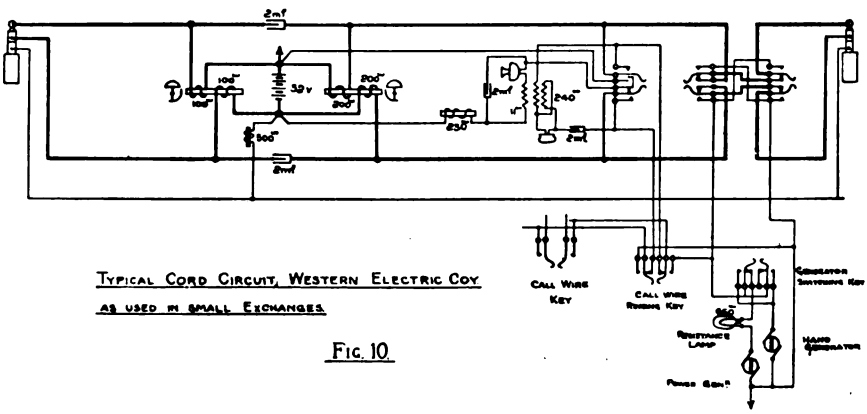
high resistance in the impeding coils, which are actually the electro-magnets of the supervisory relays. On account of these high values line resistance has a smaller effect upon the transmission when this circuit is used than is the case with either the Western Electric or Helsby circuits.

Better speaking is furnished by the Western Electric Co.'s arrangement from circuits of low resistance, but as the resistance increases the disparity disappears; at 300 ohms the circuits are equal, and beyond that value the General Electric Co.'s circuit is the better.

Apart from transmission the circuit is noteworthy, inasmuch as the signalling arrangement is peculiar to the Stromberg Carlson and General Electric Co.'s systems. The condition for the lighting of a supervisory lamp is that the electro-magnet "A" only of the



TYPICAL CORD CIRCUIT, WESTERN ELECTRIC COY AS USED IN SMALL EXCHANGES.

FIG. 10

composite relay, marked A.B. on the diagram, shall be operated; when both A and B are energised the lamp circuit is open. This type of circuit is about to be installed by the General Electric Co. in the Department's new Central Exchange at Glasgow.

Another example of the same type of speaking circuit is furnished by **10**, which indicates the typical cord circuit which the Western Electric Co. instal in small common battery exchanges. Lamps are not used, and indicators with two windings are employed for the double purpose of speaking and signalling. The resistances in this case in each coil is 100 ohms, and the battery voltage is 32. The value of the transmission furnished by this combination is approximately of the same order as that provided by the circuits already described.

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GLASGOW TRUNK EXCHANGE—NEW EQUIPMENT.

Necessity for Change and Extension.—Early in 1907 it was decided, in accordance with the general policy of obtaining immunity from fire in Post-office Telephone Exchanges, to put in hand the work of constructing a fire-resisting floor for the Trunk Exchange at the Glasgow Head Post Office, and, at the same time, to instal an exchange equipment with switch sections having iron frames, and fitted with the necessary apparatus for full junction and transfer multiples. The disposition of the present equipment, which includes forty-nine trunk switch sections, is shown on Plan No. 1.

Method of Procedure in Carrying out the Work.—In order to carry out the work with the least cost and inconvenience to traffic, the portion of the room used as Girl Learners' cloak room, Telegraph school, and writing room have been treated in the first instance, and the new plant has been installed, as shown by full lines on the "lay-out" Plan No. 2. The fire-proofing of the second portion of the room, now used as the trunk exchange, test room, etc., will be proceeded with as soon as the transfer is carried out and the present equipment recovered. The extension of the new switch will then proceed, as shown on the plan by dotted lines, as occasion requires. The switchroom has a high-pitched roof with lantern lights, but, in order to obtain accommodation for the new accumulators, power board, and time checks, a floor has been erected at a height of 12 feet over the portion allocated for the test room. The mezzanine floor thus provided is reached by a spiral staircase. There is also a doorway opening into the switchroom at a height of slightly over 12 feet to permit of the entry or removal of heavy or bulky articles.

New Equipment, Trunk Switch Sections.—The new equipment consists of 30 three-panel trunk and junction switch sections having iron frames, fully fitted with lamp signals, transfer and junction multiples, and time check signalling apparatus, as described in the paper published by the Institution on "Post Office Trunk Exchange Signalling Arrangements." Plates 6 and 7, issued with that publication, show a front and rear view of the switch sections. The trunk circuit arrangements are also as described in the same publication, with some slight modification of the junction and record circuit arrangements to meet the local conditions.

Record and Local Switch Section.—The switch section marked Record and Local on the plan is of the same construction as the three-panel trunk and junction switch sections. The three panels are fitted with local subscribers, transfer, and record circuit apparatus, whilst the keyboard is fitted as follows:

No. 1 position for 20 record operators' cord equipments; ultimate equipments 32—and

No. 2 position for 17 pairs of connecting cord equipment for local circuits. Trunk subscribers and official circuits are joined up to the local switch, the circuit arrangements being common battery signalling with lamp signals.

Record Table.—The record table is fitted at present for 20 record operators' speaking and signalling sets, with an ultimate equipment of 24. It is also fitted with a band carrier, travelling in both directions at the rate of

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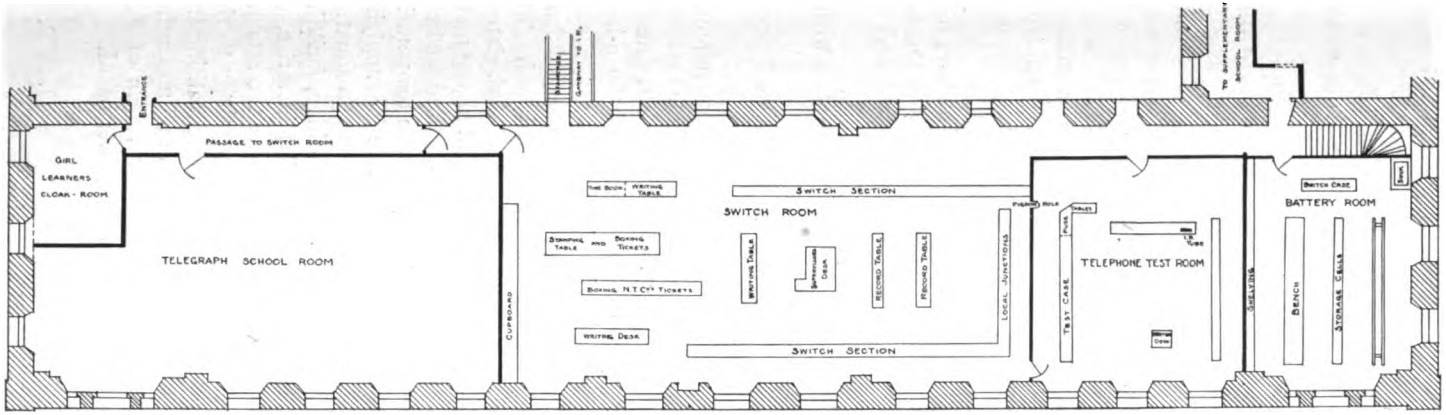
PLAN 1 PLATE 1

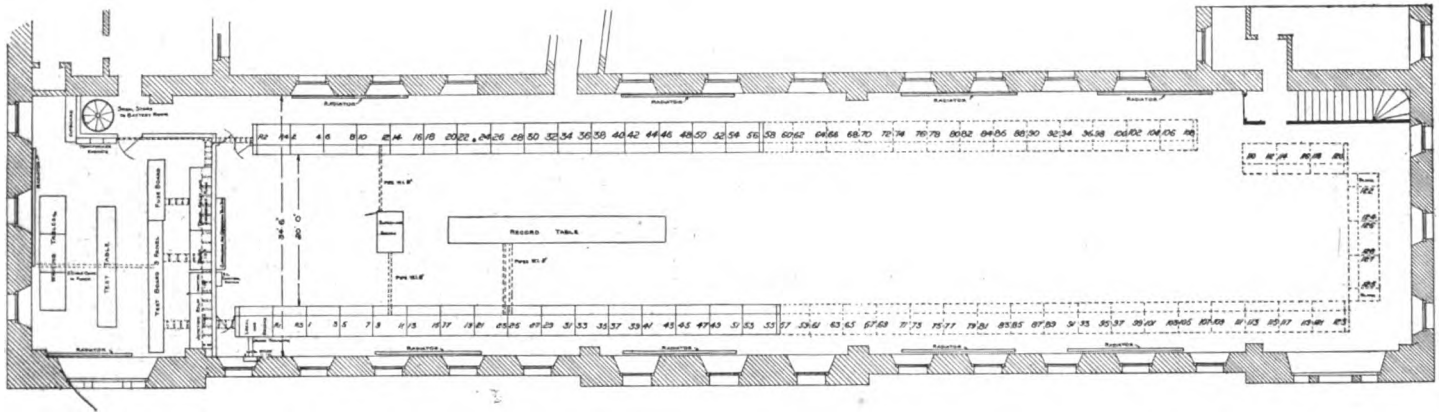
GLASGOW HEAD POST OFFICE

PLAN OF SCHOOL ROOM, SWITCH ROOM, TELEPHONE TEST, and BATTERY ROOM.



PLAN 2 PLATE 2

PLAN OF SWITCH AND TEST ROOM.



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approximately 100 feet per minute, which delivers the record tickets into boxes at either end of the table.

Supervisor's Switch Section.—A supervisor's switch section, affording the supervisor listening in facilities to each operator in the exchange, in addition to outward and inward signalling, has been provided.

Test Board.—As in all large trunk exchanges of recent date, trunk and junction circuits are brought from the main frame through a test board of the switchspring type, thence to the intermediate distributing frame. The test board is of mahogany with nine panels, having a capacity for 1800 trunk, junction, and miscellaneous circuits, and 720 switchsprings for reserve multiples, test circuits, and cross connections. Five panels have been fitted in the first instance.

Trunk and Junction Intermediate Distributing Frames, etc.—The trunk and junction intermediate distributing frames, relay and condenser racks, are of the usual type, and have a sufficient capacity to meet the ultimate requirements of the exchange.

Fuseboard.—The frame of the fuseboard is of iron, and 1196 alarm fuses of the well known bead alarm type are mounted on slate panels of the best quality. Lead cables are used exclusively between the fuseboard and the switch sections.

Transformer Cabinets.—Three transformer cabinets are provided, with a capacity of 96 transformers.

The existing test tablet and morning test apparatus will be utilised for the new equipment.

Accumulators and Power Switchboard.—The main accumulator equipment for supplying the lamp signalling and speaking current for the whole exchange consists of 4 secondary batteries of the Tudor type, each of 12 cells, fitted in glass boxes, each cell having a capacity of 720 ampere hours at the 9-hour rate. A subsidiary equipment of 4 secondary batteries of the K7 type, each of 6 cells, is provided for the P.C. signals. The batteries are charged from the Department's own supply through a separate power switchboard. The slate slabs supporting the switches and other apparatus are of dark slate of extra fine quality, oiled, enclosed in a rigid angle iron frame, and all the metal work is of the highest standard. The switching arrangements afford facilities for charging two sets of the Tudor cells in series, or leaving them temporarily spare, and at the same time the other two sets are left available for supplying the current to the Exchange. A reversing switch is provided for approximately equalising the discharge from each half of the battery. In addition, facilities are provided for charging two sets of the K7 cells (12 cells) in series, or leaving them temporarily spare, and at the same time the other two sets are joined up for supplying current at + 12 v. and − 12 v. respectively to the Exchange. A reversing switch is also provided in this case for equalising the discharges. The usual charging resistances, circuit breakers, and measuring instruments, in addition to 2 electrolytic meters, Reason type, each of 800 ampere hours capacity with 1/5 shunt, are mounted on the power board.

Plate 3 shows a portion of new switching equipment.

J. S. B.

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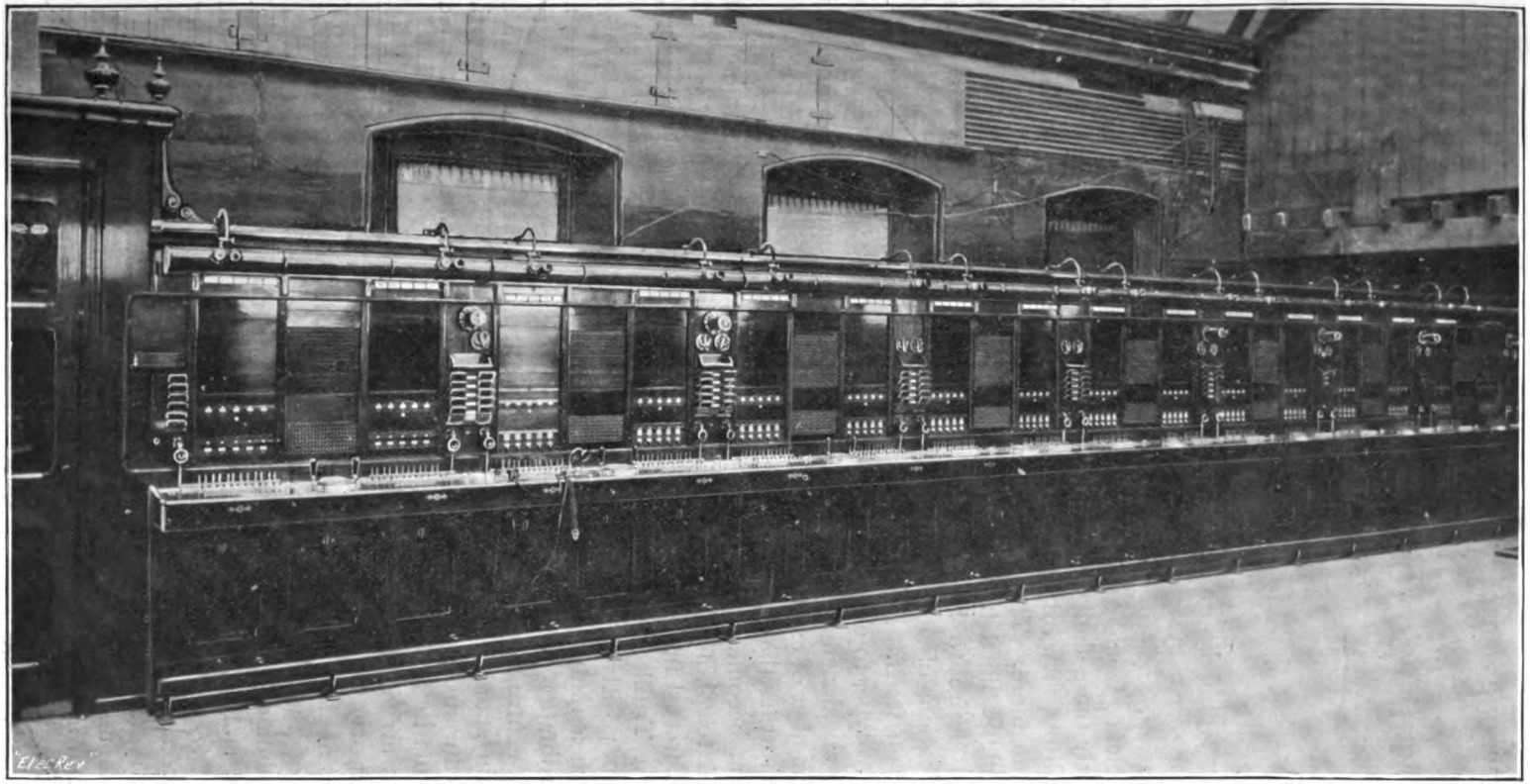

3. Glasgow Trunk Exchange.—New Sections.

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THE ZONES AND THE TRUNK-LINES.

By JOHN LEE
(Assistant Traffic Manager).

IT would be an impropriety to argue, in this place, in favour of the *Zone* system of working Trunk-lines. That system is in operation, and to bring battalions of logical military forward in its defence would seem to imply the existence of an enemy. Consequently there shall be nothing of direct polemic in this little paper. It will put forward a few main considerations of the *Zone* system, and no more. These considerations may possibly be affected and, indeed, modified by others of which I am unaware, but to which I could desire to keep an open mind. Telephony, like all other applications of science to the usage of man, has a knack of turning back on itself. Development has its circular movement—its reversion to type, to use the Darwinian phrase, and yesterday's heresy is the emboldened belief of to-day. In local telephony, for example, as the number of exchanges within an area increases, and must increase even further than we yet can realise, the deficiencies of the multiple system become plain to us. In a parallel way the development of Trunk telephony is antagonistic to a continuance of what I will call the Direct Line method. Quite naturally we think, at the outset, that a Trunk system should provide a line wherever there is a certain positive quantity of traffic between two points. That might ensure a multitude of satisfactory routes, but would it ensure a co-ordinated system as a whole? Would it provide that every trunk centre, be its traffic great or small, should have a route with a certain standardised efficiency to every other trunk centre? Until we can answer this question affirmatively we have not reached Nirvana in Trunk telephony.

In arriving at the Direct Line method as the solution we are led mostly by telegraph tradition. But the analogy is imperfect. Transmission at an intermediate point is, in Telegraphy, a duplication of the original transaction. But intermediate connection in Telephony, even though it take place on two switch sections, is a much smaller factor. Admittedly it is a factor of which we shall strive to rid the service, so long as we do not introduce other disturbing factors, such as inequalities of delay and the like. The *Zone* system, as will be seen presently, has its own remedy for much of the unfortunate loss of time in the "Through" transaction. Though in one hand it brings an apparent increase in the number of "Through" calls, it brings in its other bountiful hand a method of

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dealing with a vast proportion of the "Through" traffic which raises it, in facility of treatment, to the level of simple direct traffic.

Glancing at a map of England (and Wales, of course) we see at once that so far from being a country wherein towns and cities are equally be-peppered, there are congeries of towns here and there, each town having close business intimacy with the other, and having a grouped but less close intimacy each group with another group. We may avoid the word "*Zone*" for the present, and consider a few groups, as the word "*Zone*" will come to have a somewhat technical meaning. Now the Trunk system has two characteristic demands to face. There is the demand for quasi-local connection of a particularly prompt kind within the group, materialised, so to speak, in threepenny calls for the most part; there is the demand for long-distance calls from every town in the group to every town in the other group. The first demand will represent very heavy traffic. The second demand will represent very light traffic, if we consider each town separately, and only heavy traffic, or considerable traffic, when we deal with the group as the unit. But in each group there is a predominant partner—Manchester for the South-East Lancashire group, Newcastle for North-East England, Cardiff for South Wales, by way of examples. And the long-distance traffic from the predominating partner will be broadly representative of the long-distance traffic from the smaller towns of the group, seeing that the commercial interests are mainly identical, and will differ in degree certainly, but not at all in kind. Hence we arrive at two conclusions. By making the group the unit we can handle (*a*) the special traffic within the group, (*b*) the great, because aggregated, traffic from group to group.

Now for two postulates, albeit that postulates are about as dangerous as prophecies. The call wire and other methods of working have brought home the fact that Trunk circuits can be worked more efficiently in considerable numbers than in ones and twos. (I exclude the continuous attention method, wonderfully successful though it has been, since, as regards the cost of staff and buildings and equipment, it could never be the national system.) Govern eight lines by a superimposed Telegraph call wire, and we get the best results. There is elasticity for the distribution of traffic, and to provide for occasional interruptions of lines; there are revenue results amounting to 50 per cent. better than can be obtained by ordinary working. The second postulate is that the intermediate connection of lines is more likely to be achieved without delay, without waste of lines, where there are groups of circuits available, for the mathematical probability of coincidental clearance is raised enormously.

If we come back from these postulates to our group notion we see the inner meaning of the *Zone* System. The group is the *Zone*.

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It is a commercial rather than a geographical entity. The predominant partner is the *Z*one centre. The *Z*one centre will have sufficient traffic, with the aid of its co-operating towns, to render call wire working practicable on most of its long-distance routes. Each town in the *Z*one will have precisely the same delay to the long-distant centre, and the odiousness of unhappy comparison is obviated. The traffic from the small towns will be cultivated, and this is an important factor at the present moment, since manufacturers are showing signs of transferring their works to smaller towns. Nor will the traffic from the *Z*one centre suffer, since that town will have more lines and far more efficient working than would be the case if there were numerous lines to other *Z*ones from the subsidiary exchanges. Also the central administration is handling the traffic of the country in a scientific way, dealing with it in a series of large routes, rather than continually striving to equalise small routes for particularised traffic. But the striking truth of all is the paradox that by raising the efficiency of working the within-*Z*one lines, time is saved on the long-distance lines. A call from Warrington to London is worth one penny per minute on the Warrington-Liverpool lines, and eight times as much on the Liverpool-London lines. How important it is, therefore, to have the former lines so efficiently worked as to give an absolutely prompt connection, when such a connection is required, to the London-Liverpool line!

So forcibly has this fact driven itself home that it has placed the question of *Z*one-centre-control in the foreground. Theoretically, calls are controlled, *i.e.* they are timed on and off, at the originating point. But where a chain of circuits is involved this may mean—and frequently has meant—that some of the lines have been held for a period far longer than that for which payment has been received, which is, of course, for the completed connection. It is manifest that the circuit of which the greatest care is to be taken is the longest, and that in the bulk of cases this will be the circuit from the *Z*one centre to another *Z*one centre. Hence the operator, who will most economically control the call, is the operator who is responsible for this line, and for this reason the control of what may be called "*Z*one-outward" traffic is to be transferred to her. Various trials have been made, and they agree in proving that on every "Through" call which is transferred to *Z*one-centre-control system, something between one and a half and two minutes' revenue time is saved. I might aggregate this into its proper total of thousands of pounds, but the mathematical-minded reader will love to do it for himself.

It is probable that as time goes on the apparent loss on the less expensive, the within-*Z*one, lines will be reduced, for greater expertness in handling *Z*one traffic will produce its effect. The saving of revenue time on the long-distance circuits, however, far outweighs

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whatever loss takes place on the shorter lines. Indeed, if we might venture on the unprofitable hazards of the prophet, we might expect a development of the *Zone* system, which would have special within-*Zone* lines for the purpose. Some would say they might be multiplied on the long-distance sections, and worked after the fashion of junctions. Personally, I am inclined to think the development will be in another direction. The abolition of the area which will come to pass with the unification of the system of the country, will bring us, with the co-operation of the measured service system and its junction charges, to regard the Exchange (or the grouped Exchanges) as the unit, differing only in charge according to the distance which separates them. In their relation to the *Zone* centre the several Exchanges in the predominant town will not differ in essence from the Exchanges in the towns in the *Zone*. The wheels of progress seem to be revolving in the direction of unifying within-*Zone* work with junction work, with the possible result of rendering unnecessary so many Trunk Exchanges as there are at present. Moreover, the necessity for prompt service within the *Zones* will bring the necessity for a more prompt record system into the foreground of discussion. Some of my engineering friends will hit upon a record system for within-*Zone* traffic by which the subscribers can be connected at once from the circuit on which he makes his original demand. I hope that I may have some lowly share in helping such a venture.

But I must protest. This paper looks uncommonly like what it declared that it would not be, a defence of the *Zone* system. It is not such a defence, for now it must indicate limitations. Such a doctrine, slavishly adhered to, might be disastrous. Within the *Zone* every effort is made to connect traffic away from the *Zone* centre. Subsidiary centres are given cross connections wherever the traffic can be said to justify them. Moreover, there is something to be said in respect to the difficulty of leading lines into the centre of our vast cities. It is an expensive arrangement. An engineering friend told me the other day that he would believe in the *Zone* system if *Zone* centres were always villages with not more than a thousand inhabitants. There is much truth in the contention which lies behind his genial cynicism. But it is a modifying truth, I think, rather than an absolute truth. After all, the big centres, with their wealth of traffic, are there. Civilisation will have it so, and all the demand it makes upon each of us who strives, according to his lights, to think out the problems which follow from the fact is that we should grin and bear it. For assuredly we cannot alter it.

[I am indebted to my friend and colleague, Mr. J. Stuart Jones, for kindly perusing this paper, and for an expression of his general accord with the views expressed in it.]

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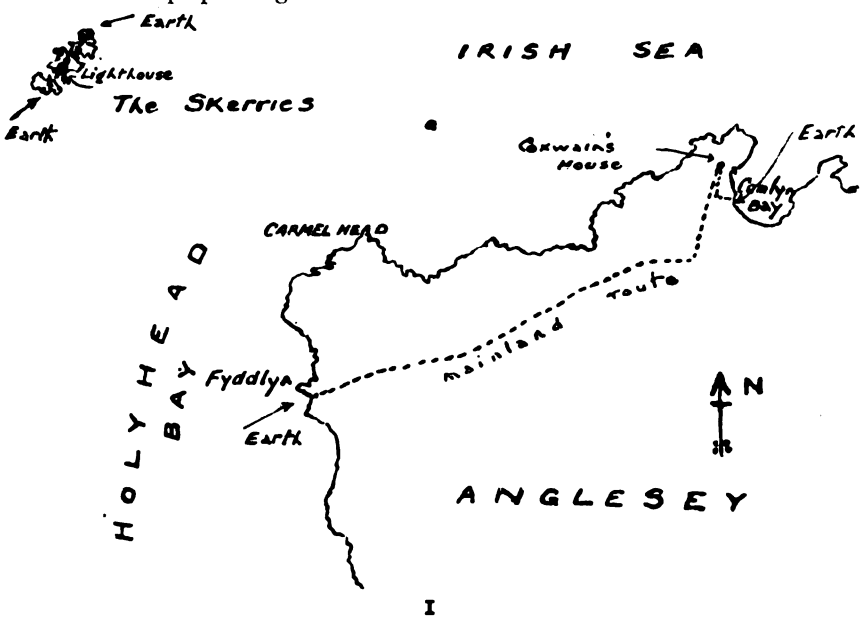
THE SKERRIES WIRELESS TELEPHONE.

By J. S. Elston.

Immediately north of Holyhead Bay, and about one and three quarter miles from the wild and rugged coast of North Anglesey, lie the "Skerries," a group of three rocky islets at high water, and an almost continuous rocky island at low water. On the centre island stands the Skerries Lighthouse, well known to mariners navigating vessels in the Irish Sea, and more especially to those sailors who seek to guide their ships to the great seaport of Liverpool. No doubt officers of ships passing the Skerries have wondered what reason there



could be in stretching over the length of the Skerries a telegraph wire whose ends lost themselves in the sea. If they knew that such wire was part of a wireless telephone arrangement, passengers on passing vessels would probably benefit by the active imaginations of the "old salts," and possibly we should read of further marvellous advances in "wireless," which occasionally transform our morning papers into small but inexpensive editions of fiction on the lines of Jules Verne's novels.

The sea between the Skerries and the mainland is exceedingly turbulent even on calm days, and it can be left to one's imagination what a sight must be possible in a storm to those on look-out duty in the lighthouse. It is obvious thus that no shore-end of a cable could be manufactured at a reasonable cost to withstand the constant

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wear on rock, and, further, the expenses of laying and maintenance would be high. It was therefore suggested by the Post Office engineers about 1899, during Sir William Preece's term of office, that the arrangement I propose to outline should be given a trial, and this was done.

The system consists of two insulated parallel conductors of unequal lengths, earthed at the ends, the adjacent ends being separated by sea; one conductor is erected on the Skerries, the other conductor is erected between Cemlyn Bay and Fyddlyn on the mainland. The route of the lines is shown by a tracing from the 1 in. Ordnance Map (1). The conductor on the Skerries is a 600 lb. copper wire erected on 24–26 ft. well-stayed poles, and is insulated by P.O. standard insulators. The line passes from an "earth" made in the sea at the S.W. end of the island, for a distance of about 300 yards, to the lighthouse, where it is led to the apparatus, and from thence to the "earth" made in the sea at the N.E. end of the island, a distance of about 500 yards; the total length of the circuit is about 800 yards. The mainland conductor consists of a 400 lb. copper wire, insulated by P.O. standard insulators, and erected on 22–30 ft. poles. The "earth" at the S.W. end of the line is made in the sea at Fyddlyn, and the line is some three miles long before it is taken to the apparatus installed in the coxswain's house at Cemlyn. The wire then doubles back on itself for about 300 yards and finally is "earthed" at Cemlyn Bay.

It will be seen from the diagram (2) that with the switch at "telephone," a receiver "C" is in series with the line and that no calling apparatus is provided. No satisfactory calling arrangement has, as yet, been devised for these circuits. In 1902 Sir O. Lodge suggested an arrangement, but on trial it was found that earth currents actuated the device almost continuously. Recent measurements of earth currents present on the mainland show that at low water the earth currents reach as high a value as 30 m.a., while at high water they are as low as 1 m.a. The readings were never steady, and fluctuated from 15–30 m.a. and again from 1–7 m.a., intermediate values of 1–30 m.a. being registered at different stages of the tide. The failure to establish a system of calling is, of course, a great drawback, rendering the service useless from a commercial point of view. At present attention is given at both stations at pre-arranged times. The first speaking trial is usually made at 9 a.m., and attendance is given each complete hour, viz. 10 a.m., 11 a.m., noon, and so on, to 6 p.m.

Passing to the electrical actions when the Skerries "speak," the press button "D" is depressed; the speaking battery, of twenty-four cells in two parallel rows, completes its circuit through the transmitter, lines, and "earths." The circuit on the mainland is completed

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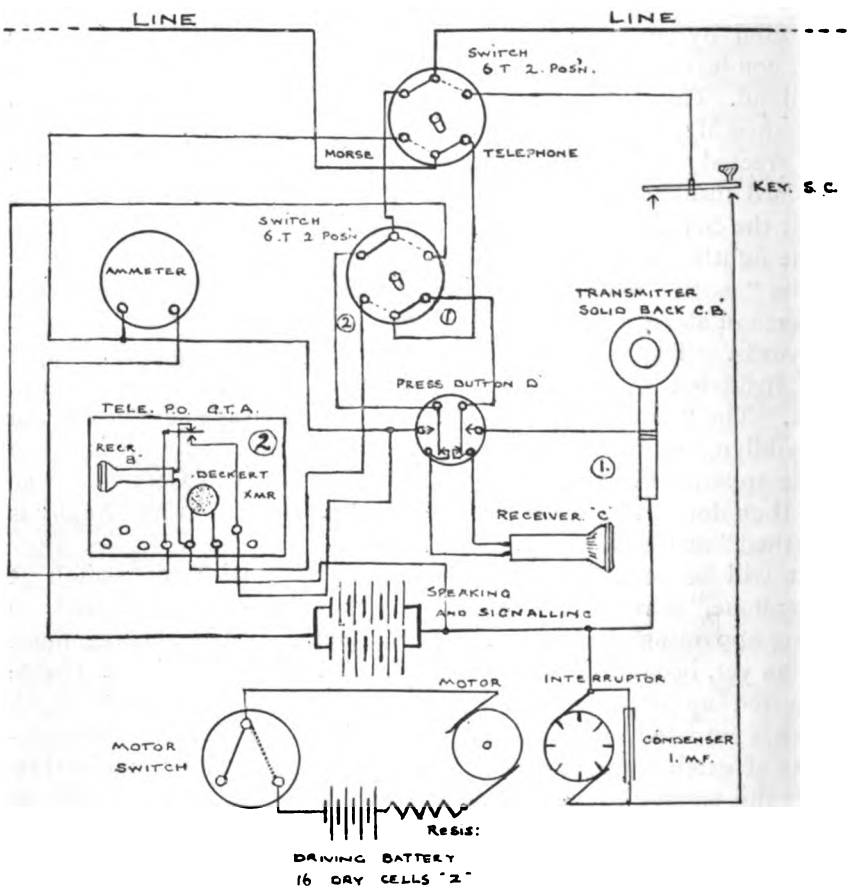
by the telephone receiver "C," lines, and "earths." In whatever manner energy is transmitted from the Skerries circuit to the mainland circuit—and I am inclined to suggest sea-conduction as the manner of transmission—it is transmitted, and faint speech is received at Cemlyn and *vice versâ*. The volume of speech varies very considerably; to put it roughly as a guess, it may be likened to five



SPEAKING AND SIGNALLING BATTERY.—20 + 20 "Z" cells—*Cemlyn.*
12 + 12 "Z" cells—*Skerries.*

To speak depress Press Button "D" or Button on Tele. P.O.

2

miles beyond the standard cable limit. It is curious that with a measured earth current of the varying values stated there is an absence of noise; the usual trouble, if any, is faint speech. At times, however, through some unknown cause, considerable noise is present; the lines may be in good order and the "earths" intact and nothing can be traced likely to cause the disturbance. It is due

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possibly to some atmospheric effect. At times, also, it is found that the reserve circuit with a Deckert transmitter gives better results than the prime circuit with a solid back C.B. transmitter.

There is also a wireless telegraph arrangement for use when the telephone circuit is too noisy or otherwise faulty, provided the trouble is not on the line circuits. The arrangement consists of a motor on whose armature is fitted an interruptor, which makes and breaks the circuit of the speaking battery. The motor is driven by sixteen "*Z*" dry cells. The interruptor and S. C. Key replace the telephone transmitter only, the remainder of the arrangements holding good for the reception of the message, which is translated from the Morse code.

The original installation remained until 1903, when Mr. J. E. Taylor, of the Engineer-in-Chief's office, acting under Sir J. Gavey, C.B., re-arranged the apparatus to the present connections and introduced the solid back transmitters, thereby increasing the volume of speech very considerably. The circuits are maintained by the Post Office for the Board of Trade. Conversations are carried on daily and interruptions are infrequent. The principal troubles are battery maintenance and washing away of "earths." It is interesting to note that at first earth-plates were tried on the Skerries, but the heaviest boulders placed on the plates were moved away as though they were pebbles by the tremendous seas which sweep the rocks during even a moderate gale. Next, stranded copper wire was led through eye-bolts driven into plugs which were inserted into holes drilled in the rock. Gradually electrolytic action weakened the iron eye-bolt and the "earth" was swept away. The last method adopted has stood since 1902. It consists of a steel rope formed of six cables of four 200 lb. stranded steel wires, the cables being bound into a rope by 200 lb. iron wire. This rope was let into a groove chiselled in the rock to the low-water mark, and was kept in position by threading it through eye-bolts, which were driven into plugs fixed as already described. The joint between the steel cable and the stranded copper earth lead was made above high-water mark.

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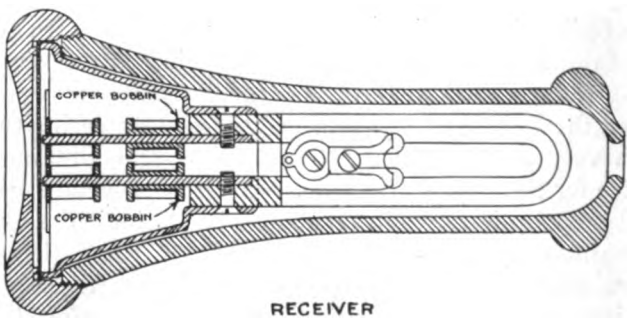
A NEW COMMON BATTERY TELEPHONE.

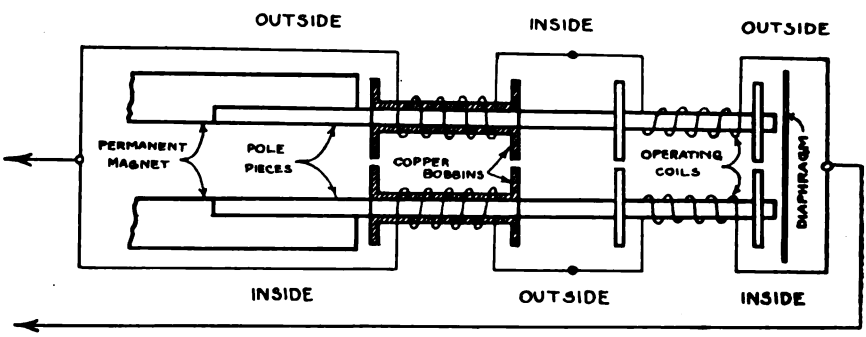
In the manufacturers' column of the *American Telephone Journal*, dated 18th December, 1907, Mr. C. D. Enochs describes a new common battery telephone which, so far as concerns transmission and reception of speech, consists merely of a transmitter and a receiver in series.

The method of eliminating any ill effects due to the direct current from the common battery circulating through the receiver coils is a novel one. From the accompanying figures 1 and 2 it will be seen that the soft iron pole pieces of the permanent magnet are longer than usual, and that upon each are fixed two separate coils, joined up so that the magnetic effect of the direct current in one is in opposition to that of the direct current in the other. As



RECEIVER

1



CIRCUIT OF RECEIVER

2

the coils on each pole are in series the current strengths will be equal, and it is claimed that the magnetic effect of the direct current in one coil is counterbalanced by that of the direct current in the other. In order, however, that this may not be the case with the high frequency telephone currents, the coil which is furthest away from the diaphragm is wound upon a copper bobbin. The currents induced in this copper bobbin will, of course, be in magnetic opposition to the currents producing them. With rapidly varying currents, therefore, the magnetic balance is upset and the coil nearest to the diaphragm will become operative. J. W. T.

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INSTITUTION NOTES.

UNDER this heading there will appear, in future issues of the JOURNAL, a *resumé* of the proceedings of each of the Centres during the quarter prior to publication; and it is hoped that by this means the local Committees will be enabled to secure new ideas with regard to the subjects of papers, the arrangement of visits to manufacturers' works, etc., and in other ways to benefit by the interchange of information as to the progress which is being made with the educational work of the Institution.

Another regular feature of this section will be the publication of such particulars of matters which have occupied, or are still engaging, the attention of the Council, as may with advantage be brought under notice in this manner.

Other items of general interest with regard to the organisation of the Institution, the modification of rules, the increase in the number and distribution of members, etc., will also appear, so that the individual member may be placed in a position to exercise that keen interest in everything affecting the Institution which is so essential if its aims are to be fully realised.

PROCEEDINGS OF THE COUNCIL.

A meeting of the Council was held at Nottingham on February 5th and 6th, 1908, the Chairman, Mr. J. W. Woods, presiding.

The following items of general interest to members have been extracted from the volume of business transacted.

District Reference Libraries.—Important additions have been made to the District Reference Libraries during the past quarter, with the object of increasing the utility of this department of the work of the Institution. The question of accommodation of the District Reference Libraries was also dealt with. The housing of the books in certain Centres was not considered satisfactory from the point of view of accessibility, and, to permit of the unrestricted use of books, it was arranged to provide accommodation in each case in the *General* Office of the Superintending Engineer.

Assistance to Centres in the Preparation of Programmes.—Reports from some Centres having indicated that difficulty had been experienced in completing the programmes for the current Session, the matter was taken up by the Council with a view to the supply of lecturers in response to any definite requests for assistance. Advantage has been taken of this arrangement by the Committee of one Centre up to the present. In this connection it is worthy of

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note that a useful leaflet has been issued to members, giving a list of suitable subjects upon which papers might be contributed.

Membership.—Some interesting facts were brought out in connection with the present membership of the Institution. From a comparison made between the membership roll and the number of officers of the different grades eligible for membership, it transpired that nearly 75 per cent. of the Staff had joined the Institution, and that the membership list was on the increase. A leaflet, setting forth the advantages of the Institution, has been issued for circulation amongst non-members, and it is hoped that this leaflet, aided by the friendly co-operation of members, will result in an augmented membership.

Election of Honorary Members.—The Council unanimously elected the following gentlemen as Honorary Members of the Institution, viz.—

Sir John Gavey, C.B. (First President of the Institution).

Mr. A. W. Heaviside, I.S.O. (formerly Superintending Engineer of the Northern District of England).

Constitution of Council.—The question of representation on the Council is at present receiving special consideration with a view to determining whether the existing system best meets all requirements.

Representation at Meetings of the Council.—In accordance with the provisions for modifying the Rules of the Institution, the Council have arranged, so far as is practicable, that no section of the membership shall be unrepresented at two successive meetings.

Audit of Accounts.—It is proposed to amend the Rules so as to provide for a professional audit of the Institution accounts.

Institution Medals.—The awards for 1906–7 are:

Senior Silver Medal: Mr. J. E. Taylor, for paper on "Electric Wave Propagation."

Senior Bronze Medal: Mr. J. G. Hill, for paper on "Telephone Transmission."

Junior Medals: Mr. A. O. Gibbon, for paper on "The Construction of Underground Telegraphs in the Provinces;" Mr. J. S. Brown, for paper on "Trunk Telephone System Signalling Arrangements."

The decision as to the award of the Silver Medal in the case of the two last-named papers has been referred to the President in accordance with the Rules

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DISTRIBUTION OF MEMBERS.

Metropolitan Centre:		
Engineer-in-Chief's Office (including Testing Branches and London Electric Light Staffs)	151	
Metropolitan Central District	66	
,, North ,,	38	
,, South ,,	64	
Southern (England) ,,	34	—353
Eastern Centre		33
North Midland Centre		35
South Midland ,,		43
North-Eastern ,,		43
Northern ,,		38
North-Western ,,		35
North Wales ,,		53
South Wales ,,		44
East Scotland ,,		21
West Scotland ,,		26
Irish ,,		34
	Total	758

LOCAL CENTRE NOTES.

METROPOLITAN CENTRE.

THE Metropolitan Centre has again completed a full session of six meetings, at each of which a gathering of 150 to 250 assembled. The programme was as follows :—

October.—"The Education of an Engineer." Major O'Meara.
"The Construction of Lead-covered Cables." Mr. R. W. Callender.

November.—"The Complete Co-ordination of Inter-urban Telegraphs and Telephones." Mr. D. H. Kennedy.

December.—"Open-line Construction." Mr. J. H. M. Wakefield.

January.—"The Management of a Metropolitan Post Office Engineer's Section." Mr. J. P. Price.

February.—"Unit Maintenance Cost." Mr. A. L. De Lattre.

March.—"The Education and Training of an Engineer." Sir John Gavey.

The long arm of coincidence is strongly manifested in the fact that the session was opened and closed by the present and past Engineers-in-Chief respectively, and that in both instances the addresses dealt with the various processes necessary for the mental equipment of the ideal Engineer. Mr. Price's paper was intended to show what the ideal Engineer would do with his Section, and was an interesting contribution which evoked considerable discussion. Mr. Kennedy's appeal, for fuller inquiry into the possibilities of "superposed" working on a grand scale, met with severe but unconvincing opposition, while Mr. Wakefield supported his case against dogmatism in Technical Instructions by a large number of lantern slides. Mr. De Lattre's excellent exposition of the original Unit Maintenance Cost System was only disappointing from the point of view of the possibilities suggested had there been a consideration of the subject itself rather than its history.

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METROPOLITAN CENTRE.

The presence of two Engineers-in-Chief (past and present respectively) on one platform attracted a large and representative attendance at the Metropolitan Centre meeting on Monday, March 9th. Under the presidency of Major O'Meara, Sir John Gavey delivered an address on the subject which has recently received much attention both in England and in America, viz. "The Education and Training of an Engineer." The address was an eloquent plea for the broadening of the basis of general knowledge necessary for success in the Engineering profession, and suggested methods of training with that end in view. The discussion which followed was animated and vigorous, and was ably opened by Mr. A. W. Heaviside. Summed up in a sentence, all the speakers argued against any proposals involving undue extension of the period of academic education; characterising it as costly and unproductive as compared with the methods which produced so many successful engineers during the last century. In replying, Sir John Gavey energetically repudiated the idea of making an expensive University Training compulsory, but, while freely testifying to the capabilities and qualifications of the present staff, he recommended to the notice of the younger members and intending entrants into the Telegraph Engineering Department the general character of the training and equipment indispensable for real success in the profession. Major O'Meara, in an able and interesting speech, made reference to the courses and subjects of training for engineers adopted in various Foreign Administrations, and offered to contribute an article on the matter to the JOURNAL, in order that he might treat it more fully than in the limited time available at the meeting.

EASTERN CENTRE.

The first meeting of the Session was held in the afternoon of the 28th January. There was a very large attendance and the great interest shown throughout the proceedings was of considerable gratification to the Committee.

The meeting was opened by the President, Mr. J. Jenkin, who, in the course of an inaugural address, full of sound advice, reviewed the past work of the Centre and referred to the great possibilities of the future. He then called upon Mr. A. W. Martin for his promised lecture on "The Unit Maintenance Cost." Some of the members had expressed a fear that the possibilities of such a subject would be extremely limited, but any such thoughts were quickly dispelled. Mr. Martin first treated the question in a general way, dealing with the principles on which the system is based and then in turn explained its immense value to the engineers, the superintending engineers, and to headquarters. He next illustrated by means of graphs how easy it enables lengths, sections and districts, etc., to be compared and suggested how, with its help, the necessary representations to headquarters when additional linemen are required could be prepared in a very simple manner. Many other points were treated in a most lucid and instructive way, which lack of space prevents us from mentioning in detail, and we must content ourselves by saying that Mr. Martin caused his audience to regard the "Unit Maintenance Cost" in a very different light from what they had previously done.

A keen discussion followed the lecture, and, in replying to the questions raised, Mr. Martin still more forcibly demonstrated the all-round value of the system.

The meeting terminated with a very hearty vote of thanks to Mr. Martin.

SOUTH MIDLAND CENTRE.

It has not been found possible to arrange for any meetings up to the present. The Council have, however, been able to arrange for Mr. De Lattre to give an address on "Maintenance," and Mr. Plummer on "The Application of Inductances to Underground Cables," and it is anticipated that these lectures will prove of extreme value.

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NORTH-EAST CENTRE.

The membership in this centre is 84·3 per cent. of eligible members, but we are hoping for an increase next year.

Five successful meetings have, so far, been held, the papers being attentively listened to, and keen discussions following.

In comparison with last year's meetings the most noticeable feature has been the readiness and interest with which members entered into the discussions. The Institution is doing good work from an educational point of view by affording facilities for an exchange of thought and experiences.

NORTH-WEST CENTRE.

The 1907–8 Session has, up to the time of going to press, been a very busy one, and promises to continue so. Six meetings are on the programme, four of which have been held.

The Chairman, Mr. J. W. Groves, opened the Session in October with an inaugural address, the papers read at the other three meetings being—

November, 1907.—"Lightning Conductors." Mr. W. B. Smith.

December, 1907.—"Induction." Mr. F. N. Harrop.

January, 1908.—"The North Underground." Mr. H. E. Martin.

NORTH WALES DISTRICT.

One of the most successful meetings of the North Wales Centre of the Institution was held on 19th February. The ordinary meeting was preceded by a demonstration by Mr. A. W. Martin (of the Headquarters Staff) of the tests that are now being carried out with "loaded" cable circuits between Manchester and Liverpool. Mr. Martin had made arrangements for listening tests to be made by those present between loaded and unloaded cables and this greatly increased the interest manifested on all sides. The marked superiority of the "loaded" over the "unloaded" circuit was a matter of general comment.

At the subsequent ordinary meeting a paper was read by Mr. Elston on "Primary Batteries." The discussion which afterwards followed was no less interesting than the paper.

From the time Mr. Martin commenced till Mr. Elston finished there was not a moment that was without interest, and we are deeply indebted to these two gentlemen for affording us such an enjoyable meeting.

SOUTH WALES CENTRE.

The fourth ordinary meeting of the South Wales Centre for the 1907–8 Session was held at Cardiff on the 18th February, 1908, when papers were read by Messrs. J. F. McMullen and T. Devereux, Sub-Engineers, Cardiff, entitled "Common Battery System, Telephone 'Trunk' and 'Local' Arrangements."

The lecturers dealt with the subject in a most lucid manner, and it was evident from the high character of the papers read that they had gone to a great deal of trouble in compiling such excellent and instructive information. An interesting set of lantern slides were shown to illustrate the lectures, which were greatly appreciated by the large number of members present.

IRELAND CENTRE.

The Institution in Ireland passed through many vissicitudes during the first year of its existence. Two of the Superintending Engineers, who would naturally have taken parental interest in it, went into retirement at the time of its birth, and a third followed their example a few months later. In addition, the Institute commenced with three Centres in Ireland, corresponding with the number of Districts existing at the time. Subsequently the number of Districts and Centres was reduced to two, and finally, when both the Superintending Engineers for Ireland came to be located in Dublin, it was decided that one Centre of the Institution would suffice. Happily, however, notwith-

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standing the untoward experiences of infancy, the Irish Centre is now doing extremely useful work.

Mr. Moir is the chairman for the current year, and his enthusiasm has been well backed up by the vigour of the Committee and the general interest of the members. During the present session papers have been read on "Linemen's Loads," by Mr. Golding; "The Training of a Lineman," by Mr. Evans; and "The Telephoning of Small Towns," by Mr. Patterson. All these practical subjects have been ably dealt with and fully discussed.

The attendance at the last meeting numbered twenty-five, which, considering the distances some of the officers had to travel, is very satisfactory.

NORTHERN CENTRE.

The winter session has been very successful, four more papers being promised than could be given during the session.

The following papers were given—

November.—Mr. Tremain. Opening Address on "Telephone Trunk-Lines."

December 3rd.—Mr. Raper. "Stores."

„ 18th.—Mr. Kitchen. "Repeaters," with lantern slides.

February 10th.—Mr. Shadforth. "Expense Accounting."

On March 9th Mr. Bellwood will read a paper on "Trunk Signalling," with lantern illustrations.

LIBRARY NOTES.

A RECENT visit to one of the first Technical Libraries of the country revealed an almost priceless collection of volumes, well-bound, well-housed, well-dusted, well-arranged, but alas! rarely, if ever, read. The Librarian keenly emphasised the intrinsic value of his charge, quoting with evident assent Roger Ascham's dictum that "reading teaches more in one year than experience in twenty," yet apparently failing to see that the accumulation of well-chosen but unopened books is the least profitable of all experiences.

The Council of our Institution has strenuously tried to avoid this. They work with a two-fold ambition. First, to ultimately possess the best library of technical literature, so far as it covers the subjects of our professional work, of any in existence. Second, that no vexatious regulations hinder its fullest use.

Pursuing this ambition the scientific and technical catalogues are examined by the Library Committee, all promising books obtained on approval, examined, and, if of value, accepted. But though the net is spread thus widely, experience shows that useful works occasionally slip past unnoticed. Suggestions from members for new books are therefore gladly welcomed.

The selection is not confined to English works. American, French and German text-books of out-standing merit have recently been added, the foreign additions, of course, being of works of which no English translation exists. During the past twelve months 100 volumes have been added, including works presented by Sir Oliver Lodge, Dr. Glazebrook (National Physical Laboratory), W. Duddell, Esq., U.S.A. Government Census Office, the Royal Society, the Institution of Electrical Engineers, and others. The total number of volumes now in the library, exclusive of the district reference libraries, is 700, representing 575 separate works.

The range of subjects represented has recently been considerably widened, and now includes text-books on accounting, brick-work, building construction, draughtsman's work, forging and smith-work, lantern-work, management of works, microscopy, paper manufacture, pattern making, roads and pavements, turbines, water softening, etc.

The Committee's chief function, then, viz. to furnish the "tools of our craft,"—for, to the professional man a collection of good technical books is as needful as a kit of tools to a carpenter,—is being steadily performed.

But there is another and equally important function to perform. Arrangements must be made whereby each member can use the library with the greatest convenience and to the best purpose. In this respect the Committee's provision is, if not unique, certainly

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exceptional, and deserves a wider publicity. Works in great demand are duplicated—in one instance to the extent of twenty-five copies. Books are despatched, as far as possible, on the day of receipt of requisition, and to the member's private address if desired. No troublesome time-limit is imposed: books may be retained until required by another member. Finally, a detailed and descriptive catalogue is being prepared which will briefly indicate the scope and general contents of each work, and thereby place the technical treasure-house of the Institution completely at the disposal of the most distant of its members.

J. M. CRAWFORD.

SOCIAL.

EASTERN CENTRE.

FOLLOWING the meeting of the I.P.O.E.E., at Cambridge on the 28th January, a dinner was held at the Castel Hotel. The chair was taken by the Superintending Engineer, Mr. J. Jenkin, the Vice-Chairmen being Mr. E. H. Shaughnessy, Assistant Superintending Engineer, and Mr. C. P. Walby, Chief Clerk. Close upon sixty sat down, and a thoroughly enjoyable evening was spent, the proceedings throughout being of the most pleasant and harmonious character.

The outstanding incident of the evening was a presentation to Mr. A. W. Martin (who was about to leave the District to take up the appointment of 1st Class Staff Officer), of an enlarged photograph of the Headquarter Staff on behalf of those officers, and of a silver tea service which had been subscribed for by members of all classes throughout the District.

Later in the evening Mr. G. Y. Fryer, of the Clerical Staff, was presented with a handsome overmantel as an expression of the good wishes of his colleagues on the occasion of his recent marriage.

There is a widely expressed desire that a dinner shall be held annually, and it is to be sincerely hoped that this will be found to be possible.

NORTH-WESTERN CENTRE.

A very successful Staff Dinner and Concert were held on the 16th November, at which there were forty-six present, including representatives from the North Wales and the Metropolitan Central Districts.

At the conclusion of the January meeting of the Institution a "hot-pot" supper was partaken of by a good muster of the Staff, and afterwards a smoking concert was held.

METROPOLITAN SOUTH DISTRICT.

The above District held their annual Conversazione on February 29th last. The gathering, which takes the form of a Concert and Dance at the District Headquarters, was, if anything, more successful even than its predecessors. Two large rooms in the office were converted into concert and dance rooms respectively, their tasteful appearance being eloquent testimony to the energy and resourcefulness of the Organising Committee and their assistants. The chair was occupied by the Superintending Engineer, and among the guests were: Major O'Meara, Mr. C. T. Fleetwood, Mr. J. W. Woods, Mr. W. Noble, Mr. R. McIlroy, and Mr. T. E. P. Stretche, whilst Mr. A. J. Stubbs and Captain Roberts sent expressions of regret at their absence. A strong musical programme was discussed in conjunction with dainty refreshments. Mesdames Cloydon, Edwards, and Reid, and Messrs. Ivison and Gamgee delighted the company with tuneful songs, whilst the humorous section of the programme was well sustained by Messrs. J. Hillier, F. Hudson, and A. Chantrill. The excellent recitations by Mr. J. J. French and violin solos by Mr. A. H. Morse were well appreciated, whilst Mr. F. Froud at the piano was all that could be desired. The proceedings terminated with three rousing cheers for the chairman, and a hearty vote of thanks to the committee—Messrs. F. W. Heath, T. A. Claydon, A. W. Field, and L. D. Pither—who are to be warmly congratulated on the success attending their efforts.

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CHESS CLUB NOTES.

THE chief event of the season, so far as the Engineering Department Chess Club is concerned, was the visit of Dr. Lasker to the Club's headquarters in Cheapside on the 13th March. It was at first thought that the whole of the champion's time, during his stay in England, was filled up, but at the last moment Dr. Lasker was able to offer the date in question. Dr. Lasker gave a short lecture on chess, and then a simultaneous display on twenty boards. Ten of the players were drawn from the G.P.O. North Club, who co-operated in this matter with the Engineering Department Club.

The first round of the Club tournament is rapidly drawing to a close. The following have qualified for the final round:—Class A, Section 1, Mr. De Lattre. Class B, Mr. Mitton. In the remaining sections the competition has not yet been completed.

The following is the score against the Paymaster-General's Office in the Civil Service League match, played on the 11th February, 1908, at Cheapside:—

Board.	Engineering Dept.		Paymaster-Gen. Office.	
1	A. L. De Lattre	0	J. Mahood	1
2	W. D. Frewin	1	C. E. Doubleday	0
3	R. A. Wells	0	R. C. Taylor	1
4	C. W. Cornwell	0	W. Smith	1
5	R. Smerdon	0	E. A. Eagar	1
6	W. L. Harrison	0	W. H. Maunder	1
7	S. Bartholomew	1	J. B. Denny	0
8	E. H. M. Slattery	1	F. W. Parker	0
9	W. H. Stephenson	1	L. J. Baker	0
10	W. Patey	1	R. H. Sandes	0
11	T. B. Braund	0	A. M. Johnson	1
12	J. W. Kimber	0	J. S. McIntyre	1
		5		7

The result was in doubt till the last, when adjudication on three unfinished games gave the victory to the Paymaster-General's Office.

VISITS TO MANUFACTURERS' WORKS, ETC.

METROPOLITAN CENTRE.

ONE interesting feature of the past session was a series of "visits," which included the Central and Trunk Exchanges, the Testing Branch and the Electric Lighting and other plant at the G.P.O. East, G.P.O. West, Mount Pleasant, and the Savings Bank. An average of over fifty members participated in the visits, all of which, save one, took place on the nights of Centre meetings. The movement is the outcome of several requests that the Committee should arrange for official visits to large manufacturing works and other establishments connected with the various branches of electrical activity and the success of an experimental programme confined to Post Office buildings and installations is a certain indication of the support that awaits a more ambitious scheme.

NORTH WALES CENTRE.

The Local Committee were invited by the Liverpool Chamber of Commerce to attend on Monday, the 24th February, a lecture by Marconi on "Wireless Telegraphy." As was to be expected the lecturer dealt with the commercial rather than the scientific side of the subject, and his address was confined to the rise and progress of his discoveries and their future prospects and utility.

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NORTH-WESTERN CENTRE.

Two very successful and instructive visits to manufacturers' works have been organised during the present session, viz., to Messrs. The British Westinghouse Co.'s Works, Trafford Park, Manchester, and Messrs. The Chloride Electrical Storage Co.'s Works, near Manchester.

Before the first number of our JOURNAL appears, a visit will also have been paid to Messrs. F. Smith and Co.'s Wire Drawing Works, Salford, which will, without doubt, prove equally as interesting and instructive as the preceding visits.

NORTH MIDLAND CENTRE.

On the 10th February, about 70 members of the Nottingham Guild of Mechanical and Electrical Engineers visited the head office at Nottingham, at the invitation of Mr. T. J. West, a vice-president of that Guild. They were conducted through the various departments by Mr. West and some members of his staff, and it was evident they thoroughly appreciated the knowledge obtained of the inner working of a large post office.

COLONIAL AND FOREIGN NOTES.

Contributions are invited from readers abroad.

CORRESPONDENCE.

To the Editors of THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL.

MULTIPLICITY OF INSTRUCTIONS.

IN these days when one's interests are so varied it is impossible to carry in mind detailed knowledge of each and every subject. One's aim is, therefore, to classify information, and to index it—in the mind and in written records—so that precise details can be obtained at any time for immediate application. Perhaps it would be of general interest to consider the application of this everyday practice in the Engineering Department.

The work of the Engineering Department comprises, but is not limited to, telegraph, telephone, and electric light and power work. Apart from the Post Office each of these branches of electrical work stands by itself: it is specialised; there are telephone, telegraph, and power engineers—indeed, there are indoor and outdoor engineers of all three classes. But the Postmaster-General's interests are so vast, and so great is their variety, that the Post Office engineering officer must be all these, and he may at any time be called upon to deal with questions arising out of any branch of electrical work in its most complex form. Moreover, he must have a thorough knowledge of the Telegraph Acts, over and above his acquaintance with the regulations under which other undertakers work, he must have a clear understanding of the complex relations between the Department and the staff, and last, but far from least, he must have a sound knowledge of the Department's complicated system of accounting. And each of these subjects becomes more intricate every day, and the Department's methods are constantly being changed. It follows that an enormous number of instructions must be issued, and, in the interests of a heavily loaded and painstaking staff, these instructions should be issued in such a form that information on any point can be easily and quickly obtained.

But at the present time there are Regulations, Monthly Circulars, Technical Instructions, E Circulars, E in C Memos, and others; many are out of date, and others have been issued, with all due deference be it said, without reference to existing instructions. It is not exaggerating to say that at the present time not one knows definitely which of the circulars issued during the past ten years are in force.

It should not be a difficult matter, in these days of card indexes, patent files, and other office records, to devise a scheme by which complete instructions on any one subject could be easily found, and I am sure it would be of interest to readers of the JOURNAL if any who have interested themselves in the subject would discuss the matter through the medium of the Correspondence Column.—Yours faithfully, **PERPLEXED.**

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To the Editors of THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL.

ENGINEERING ACCOUNTS.

The recent remarks of the Engineer-in-Chief to the Institute of Post Office Electrical Engineers, as well as those contained in the speeches of the Postmaster-General and the Secretary at the annual dinner of the Engineering Department, and in the Secretary's further speech at the Royal Engineers' annual gathering have raised hopes that the Department is realising the severe strain which the progressive elaboration of the accounting system has thrown upon the staff throughout the country. All these high authorities referred somewhat apologetically to the matter, and dwelt upon the importance of the accounting side of an Engineer's duties.

While these signs of the times are gratefully noted, I think we may fairly ask our chiefs to believe that the necessity for good and accurate accounting is a point which Engineers have never failed to realise or thought of calling in question. The present feeling of resentment associated with this subject in the minds of so many Engineers is not due to indifference or want of appreciation, but rather to the fact that they have all along been in a better position than the higher authorities to realise the futility of much of the laborious and microscopic accounting work which has been thrust upon them and their workmen, as well as to realise the serious deleterious effect upon their engineering work which the absorption of so much of their scanty time in this unremunerative way has caused. On the question of appropriation, for example, we are all fully alive to the fact that, while we have been forced to subdivide running charges of all kinds into minute fractions of a penny, there are numerous large items of expenditure which have necessarily to be appropriated in bulk at headquarters, and which entirely nullify these attempts at mathematical exactitude of subdivision. In brief, I need only mention the large sums represented by headquarters salaries, freight of stores, interest on value of stores in depôts, and discrepancies between the fixed "rate-book" values used in accounting, and the fluctuating market value of materials.

We rejoice to think that there is at last a prospect that wiser counsels will prevail, and that a system better adapted to the needs and conditions of the service may be introduced.

"ENGINEER."

To the Editors of THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL.

THE ART OF GETTING THINGS DONE.

The comparison between civil servants and the fountains in Trafalgar Square, which play between the hours of 10 and 4, is notorious. No doubt it is repudiated by all civil servants, but it is a gross travesty of the facts when applied to the Engineering Department of the Post Office, which claims that it can carry out work as well as any organisation performing similar work. At the same time the vast organisation of the Post Office, and the consequent complexity of its arrangements, create a considerable amount of *inertia* which can only be transformed into kinetic energy if every member of the staff strives to do his work, not only well, but expeditiously.

"Lose this day loitering—'twill be the same story
To-morrow—and the next more dilatory;
Then indecision brings its own delays,
And days are lost lamenting o'er lost days.
Are you in earnest? Seize this very minute—
What you can do, or dream you can, begin it,
Boldness has genius, power, and magic in it,
Only engage, and then the mind grows heated—
Begin it, and the work will be completed."—*Goethe.*

It is obvious, however, that, if work is to be expeditiously performed, each and all must be ever on the watch to simplify the procedure. There is a natural tendency in the officer who is engaged on detail work to go into greater detail—to ask innumerable questions; and he exhibits remarkable persistence. In an organisation like the Post Office much of the complex character of the work is inevitable, but many of its intricacies have their origin in this development of method in officers immersed in detail work.

Much can be done to simplify matters, however, and the solution of the question does not lie only in great administrative changes, but in numerous small modifications which it is within the province of individual officers to make or suggest. It is a difficult task; but a high standard of excellence can only be attained by adopting a high ideal and working earnestly and steadily towards it. The non-essentials must be cut away, new ideas must be welcomed and considered, and there must be no standing upon ceremony with colleagues whose aim, like ours, is the welfare of the Department.

The cordial co-operation of an Engineering staff, imbued with this spirit, can only result in a standard of work which cannot be excelled, and a frank and full recognition of its efforts must follow.

SIMPLICITAS.

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STAFF CHANGES.

NOTE.—It should be clearly understood that these lists are unofficial; but every effort is made to render them accurate and complete.

BRITISH POST OFFICE.*
ENGINEERING DEPARTMENT.

PROMOTIONS.

Name.	Appointment.	District.	Previous Service.
Medlyn, W. J.	Asst. Suptg. Engr.	N.W.	Tel., Cardiff; Jun. Clk.; Relay Clk.; Engr., 2nd Cl.; Engr., 1st Cl.; Staff Engr, 2nd Cl.
Harriss, E.	Engr., 1st Cl.	N.Wa.	Tel., C.T.O.; Sub. Engr.; Engr., 2nd Cl.
Nimmo, R.	Engr., 1st Cl.	N.W.	Tel. C.T.O.; Sub. Engr.; Engr., 2nd Cl.
Hutchons, E. R.	3rd Navg. Offr.	Monarch	4th Navigating Offr., Monarch.

RETIREMENT.

Smart, W. S.	Engr., 1st Cl.	N.	E.T. Co.; Tel., Hull; Insp.; Engr., 1st Cl.

TRANSFERS.

Name.	Rank.	District. From	District. To
Downing, G. H.	Ch. Clk.	N.W.	Met. C.
Moon, W.	Engr., 1st Cl.	Met. C.	Met. N.
Lack, E.	Engr., 1st Cl.	Met. S.	Met. C.
Wilson, R.	Engr., 2nd Cl.	Met. S.	Met. C.
Fewtrell, J. W.	Engr., 2nd Cl.	Met. S.	Met. C.
McCloskey, A. E.	Sub-Engr.	Met. C.	E. in CO.
Aspinall, H. O.	Sub-Engr.	Met. S.	Met. C.
Evans, T.	Sub-Engr.	Met. S.	Met. C.
Hill, G. A. D.	Sub-Engr.	Met. S.	Met. C.
Davies, E. I. S.	Sub-Engr.	Met. S.	Met. C.
Hartnell, C. H. B.	Sub-Engr.	Met. S.	Met. C.
Gamgee, A.	Clk., 3rd Cl.	Met. S.	Met. C.

ABBREVIATIONS.

Asst., Assistant; C.C. & T., Counter Clerk and Telegraphist; Ch., Chief; Cl., Class; Clk., Clerk; Cont., Controller; Div., Division; Engr., Engineer; Exr., Examiner; Gr., Grade; Hd., Head; Hr., Higher; Insp., Inspector; Jr., Junior; Lr., Lower; Offr., Officer; Over., Overseer; P., Postal; Pn., Postman; Prin., Principal; Prob., Probationary; Prov., Provinces; Sec., Secretary; Sen., Senior; S.C. & T., Sorting Clerk and Telegraphist; Sr., Sorter; Stg., Sorting; Sta., Stationary; Supply., Supplementary; Sur., Surveyor; Super., Superintendent or Supervisor; Tech., Technical; Tel., Telegraphist; Temp., Temporary; Wtg., Writing.

Dist., District; E., East; I., Ireland; Met., Metropolitan; M., Midland; N., North; Scot., Scotland; S., South; Wa., Wales; W., West.

* It is hoped to include similar information from Colonial Administrations in future issues.

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DESIGNS COMPETITION.

THE Designs Competition which was advertised in the preliminary announcement of the JOURNAL evoked a bewildering display of artistic talent, and the Selection Committee had a very difficult task to perform. We hope our readers will agree that they have chosen a design which is at once suitable and striking, and which, while exceedingly artistic, performs exceptionally well the utilitarian function of indicating what is contained within the covers. It is somewhat remarkable that Mr. O. P. Moller, who submitted the winning design, also succeeded in carrying off a similar prize in the competition held last year for a design for the Institution Medal.

Designs were submitted by the undermentioned gentlemen, and in view of the high character of the designs submitted by the four gentlemen who have been commended, the Board of Editors have forwarded to them additional (consolation) prizes of 10s. 6d. each.

RESULT OF COMPETITION.

O. P. Moller, London, Prize, three guineas.

C. P. Armstrong, Newcastle-on-Tyne.
W. J. James, London.
J. Mawson, Sheffield (2).
E. W. Pettit, London.
} *Commended.*

F. Bate, Birmingham.
A. L. Blackstaffe (2), London.
B. C. Bouquet, London.
F. H. J. Bunt (2), London.
O. Dawson, London.
R. H. Ellis, Newcastle-on-Tyne.
W. E. Gibbard, Cambridge.
H. Gusterson, London.
H. J. Loney, London.
W. V. Ryder, Lincoln.
W. Simpson, Barrow-in-Furness.
A. F. Shaw, London.
A. C. Smith (2), London.
W. E. Trist, Brighton.

Reproductions of the designs submitted by Messrs. Armstrong, James, Mawson, and Pettit, are shown upon page 63.

J. MAWSON.	C. P. ARMSTRONG.
W. J. JAMES.	E. W. PETTIT.

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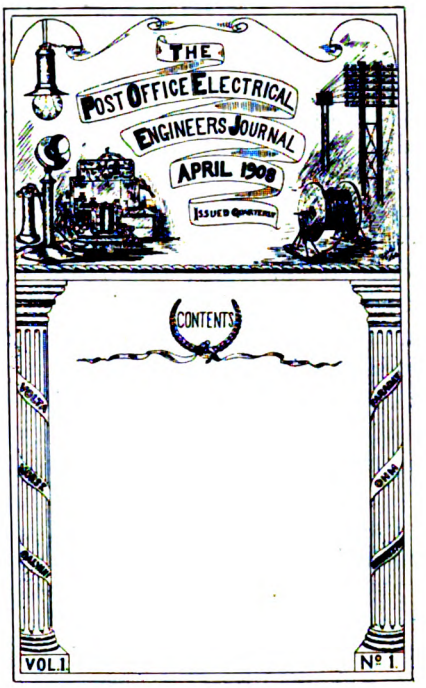

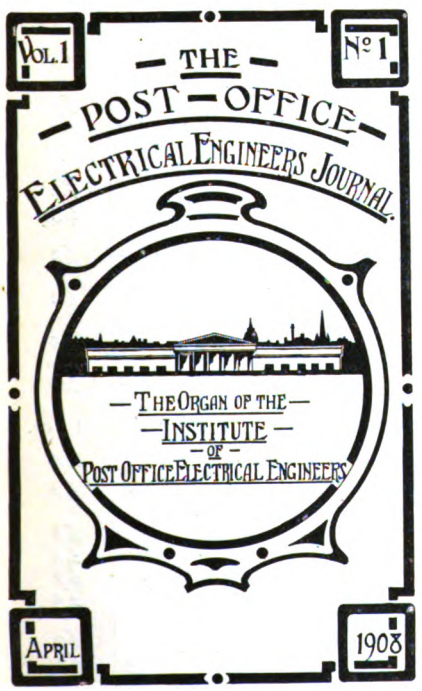

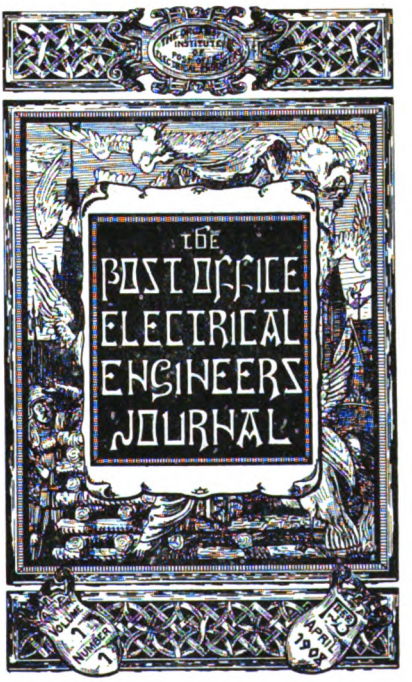

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THE AWARDS COMMITTEE.

THE scheme of awards for suggestions which has for some time been in operation in the Post Office Factories is now, by the direction of the Postmaster-General, extended to apply to all officers of the Department other than those on clerical and supervisory classes. Considerable advantage has been taken of this concession.

Suggestions tending to greater economy in production or increased efficiency, new designs of tools, improvement of existing tools, new designs or improvements in machines and apparatus, alterations in methods of manufacture, saving of waste materials, means of utilisation of cheaper forms of materials, prevention of accidents, etc., may be submitted to the Committee.

The scheme is not confined to the Telegraph Service, but applies to the whole of the Post Office.

Some 600 suggestions were dealt with up to the end of last year; of this number 101 have been adopted or have led to some improvement in practice.

Awards ranging from 5s. to £10 have been made in 196 cases, representing some £185.

A summary of the most important items may be of interest.

Case No.	Name.	Subject.	Award.
4	D. J. Ross, Holloway	Coin Collecting Box—improvement for ensuring correct registering.	£3
8	E. H. Hebden, do.	Trunk Time Check.	£2
9	W. Coleman, do.	Switch, 6-terminal, 2-position, to act also as 7-terminal, 2-position.	£2
21	W. N. Harradine, do.	Tool for painting labels.	£5
22	G. H. Willmot, do.	Fibre Cases for Detectors.	£2
29	C. S. Bull, S.W.D. Office	Improvement in working Telephone Switch Boards.	£3
94	G. T. Willmot, General Factory	Cable Grip, improved method of construction.	£2
97	F. W. Newman, Basingstoke	A. B. C. Communicators, improvement in collecting spring.	£2
106	M. W. S. Tetmeky, Holloway	Press Tool.	£5
115	Do. do.	Improvement in Press Tools.	£10
148	S. A. Colles, do.	Headgear Receivers and Sounders, improvement in ball-socket fitting.	£2
166	W. N. Harradine, do.	Tool for use with Engraving Machine.	£2 10s.
262	C. N. Singleton, H. Wilson } Reigate	Cycle Carrier Guard (Postal).	£2
317	Wm. Clarke, S.C. & T., Exeter	Concentrator Switch, improvement of Plug and Socket on Plug Keys.	£2
334	M. W. S. Tetmeky, Holloway	Design for Press Tool.	£2
358	H. G. S. Durrand, do.	Trunk Time Check.	£3
366	T. Russell, Sorter, I.D.	String Holder (London Postal Service).	£2
458	A. E. Petty, Mechanic, Met. Central	Murray Creed apparatus, improved spring for operating clutch on Printer.	£2
542	H. Piles, General Factory	Jointers' Stoves, Auto-byepass.	£2
646	C. J. Evans, Met. Cen. Dist.	Curved linings for Cable Distribution Heads.	£4

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The 196 cases receiving awards were contributed by:—

The Factories	129
Engineering Department . .	33
Postal and Telegraph Services . .	32
Controller of Stores . . .	2
	196

It will thus be noted that, despite the fact that only the minor staff of the Engineering Department may submit suggestions to the Committee, a constant stream of suggestions for the improvement of apparatus and methods is being received at Headquarters from all districts. It would be difficult to find a parallel in a commercial undertaking, and the facts tend to show how great is the amount of zeal displayed by the staff.

INTERNATIONAL TELEGRAPHY!

A Lay from the Cable Room.

When "A and Z" becomes the wail,
'Tis London answers why;
Because no Hughes' machine *can* fail
Beneath a foreign sky! . . .

"Blanks," says the Teuton overseas;
"I'm running out," says he.
"Now, no blank nonsense, if you please—
But just attend to me!"

With "blanks" and "ints," with "ints" and blanks"
We lose the shining hour;
And little meed of fruits or thanks
Repays our wasted power!

Sometimes each instrument we take
Seems burdened with a curse;
For every signal that we make
"Comes better bad than worse!"*

Till e'en the gummer owns his pain . . . .
But lo!—a change of cheer!—
We call our foreign friend in vain.
"He goes to get much beer!"*

And when at length is drained the flask
Wherewith that sinner sinned,
"What is your weather, sir?" we ask.
"Few rain and any wind!"*

Oh, shades of David Hughes, the great,
And Kelvin, famed afar,
How restful is thy last estate—
No cables where ye are!

Ed. E. Baugh.

Lowestoft Relay Office.

* Words literally used over the wires.

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"HOWLERS, TECHNOLOGICAL."

By EXAMINER.

I PROPOSE in this and in some subsequent issues of the JOURNAL to give a few "Howlers" taken from actual examination papers set in Telegraphy and Telephony. Except where only quotations are made, the answers are given in full, the language and punctuation of the candidate being used.

Whilst the Howlers may afford some amusement to readers generally, they may serve a useful purpose by showing to those readers who are teachers how it is that some students fail to obtain certificates.

Question: Describe the ordinary method of laying underground telegraphs.

Answer: The wire is drawn through a hole in the ground and at certain distances there is an opening so that the wire can be seen all the more easily.

Question: What is meant by the "specific resistance" and "specific electrostatic capacity" of an insulating substance, and how can they be measured?

Answer: The specific resistance is a constant abstract comparative quantity and does not vary as or inversely as sectional area, mass, etc., etc.

Specific electrostatic capacity is the capacity of, as it were, sucking up the electrification due to a current, so to speak, of electricity.

I do not know how they can be exactly measured, but I should think that perhaps if a current were made to tend as it were, to pass through them and a galvanometer put in circuit, the amount of leakage from the insulator to earth could be calculated mathematically.

(Here followed a rather elaborate sketch of a galvanometer with a battery and a coil of wire in circuit.)

Question: Describe any form of dry battery, and illustrate the same by a sectional sketch.

Answer: A dry cell is a moist cell without any *liquid*. It is always a modification of the Leclanche, and the zinc plate is in all cases the containing vessel, so to speak. The exciting *fluid* is jellied, being generally a mixture of ammoniated chloride, gelatine, plaster of Paris, flour, and indeed anything that tends to keep moist without making a mess. The whole is pitched over the top.

A still more dry (!) answer was given by another candidate, who stated that: "A magneto generator may be said to be a 'dry' battery, and consists of several horse-shoe magnets placed parallel." This

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was followed by a rather elaborate sketch of a generator, and the candidate ended his attempts to answer questions by informing "Mr. Examiner" that he had no time to finish.

Question: Describe the various methods of providing against damage to apparatus by lightning, and state which is the best.

Answer: The only reliable method is to cover the whole apparatus with a conducting metal and connect all to earth.

(An exactly similar answer was given by another candidate from the same town. It is evidently inadvisable for teachers to indulge in extreme language.)

Another answer to the same question was as follows: "The best way is having an instrument which has a patent for lightning at each end of its circuit in the same room."

Question: What are the relative advantages of single and double current Morse working?

Answer: D.C. working is better. It is one of the grandest inventions in telegraphy that has ever been made. In fact it is through this invention that others on the same lines has been invented with this working instrument.

Question: What should be the breaking stress of a wire 250 mils. diameter, in order that this may be equivalent to a breaking stress of 30 tons per square inch?

Answer: The Breaking Stress = 30 tons per square inch

$\therefore$ " " " = $7\frac{1}{2}$ per inch

or one inch Breaking Stress is $7\frac{1}{2}$ tons,

$\therefore$ on $250 \times 8 \times 40 \times 5\frac{1}{2} \times 3 \times 12 \times 7\frac{1}{2}$

$$= \frac{250 \times 8 \times 40 \times 11 \times 3 \times 12 \times 15}{2 \times 2}$$

= 118,800,000 tons.

Elaborate but mixed and rough calculations covered a page and a half of foolscap, and this being the last question attempted by the candidate, he finished with—

"Respectfully submitted as the best work of your humble servant

John P—."

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POST OFFICE ENGINEERING DEPARTMENT, LONDON.

Fifth Annual Dinner.

The above dinner was held at the Grand Hotel, Trafalgar Square, on Tuesday, February 18th, Major O'Meara, C.M.G., R.E., Engineer-in-Chief, presiding.

The guests of the evening included the Right Hon. Sydney Buxton, M.P. (Postmaster-General), Mr. Babington Smith, C.B., C.S.I. (Secretary), Mr. A. F. King, Mr. H. S. Carey, Mr. A. M. J. Ogilvie, Sir John Gavey, C.B., Sir John Cameron Lamb, C.B., C.M.G., Hon. R. D. Denman, Lieut.-Colonel Price, C.M.G., Dr. Glazebrook, Dr. Walmesley, Mr. G. Morgan, Mr. A. E. Eames, Mr. J. Kingsbury, Mr. H. Hirst, Mr. J. W. Willmot, etc., etc.

After the Royal Toasts had been duly honoured,

Mr. Sydney Buxton, in proposing the toast of "The Engineering Department," said:

The toast which has been given to my charge is "The Engineering Department." It is also the toast which I think I had the honour of proposing last year, and I can only say that it has given me very great pleasure, as the momentary head of this great public department, to be able to accept the kind invitation conveyed to me to be present here this evening, because I think that these functions have great merits in the fact that they bring together all those who are working for the public interest in such a great department as the Engineering Department of the Post Office. Now, since we met last year, I think we have experienced a loss, inasmuch as we have lost Sir John Gavey, but I am glad that he is going to remain and retain a continued interest in the Engineering Department of the Post Office, because, like Sir William Preece when he retired, we have retained Sir John Gavey, I need hardly say at an enormous fee (laughter), to keep a watching brief over various matters which may occur in the future (applause), one of which—perhaps the most serious of which—will be the tussle which we shall have with the National Telephone Company in 1911.

Now, I am afraid that I have to confess, as head of the Post Office, and therefore head of the Engineering Department, I am afraid that I have to confess that of late we have put rather an extra strain on our Engineering Department. I wish to recognise to the full the zeal which has actuated the members of this department in carrying out the duties allotted to them, in some cases under severe strain and severe pressure. It is our desire—we have already plans for alleviating that strain—it is our desire to alleviate it still more in the future. As you know, the work of the Telegraph Department

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has grown rapidly, and as you know, principally as members of the Post Office Service, revisions are not of the most rapid description (laughter), and the work always grows quicker than it can be carried out. Still, I do appreciate that in London, and still more in the provinces, there has been a certain amount, and in some cases a considerable amount of over-pressure, which we hope to be able in future to largely alleviate. (Hear, hear.)

You in the Engineering Department have two difficulties in the way of carrying out your duties to your country: one is the question of wayleaves, and the other is the question of money. (Hear, hear.)

On the question of wayleaves, I am endeavouring—not, so far, with great success—to pass a Bill through the House of Commons, which will give us greater powers of dealing with the obstruction of individuals who so often obstruct our telephone and telegraph lines. (Applause.) I confess I think it is a monstrous thing that a capricious individual—because in these cases it is nearly always a capricious individual, not a man who has the public interest at heart—that a capricious individual is able to obstruct our progress, and, to use a term familiar in the Post Office in other directions, to "blackmail" us if he allows us wayleaves at all. I am glad to think that, apart from an Act of Parliament dealing with these gentlemen, we have been more successful than usual of late in dealing with obstructive and capricious local authorities. I wish Sir Robert Hunter was here this evening, because I would venture in the various actions he has brought during the last two years, I would venture to compare him to Wellington, who never lost a gun. (Applause.) Sir Robert Hunter has brought many actions in the past two years against local authorities, and I do not think he has lost a single one of them. He has also made them pay the cost of the actions. These are the obstructions of the local authorities with whom you gentlemen have to deal. There is, as I said, another body also with whom we have to deal, and that is the Treasury. Some people think that the Postmaster-General, in this matter, has considerable power and authority, but the Treasury is far and away above the Postmaster-General. It reminds me a little of the picture in 'Punch' in the old days, one of Du Maurier's, I think, in which a bishop's page-boy, having committed some delinquency, the bishop is chastising him and is utilising the occasion for a little moral sermon, and he says to the page-boy: "Who is it whose eye is ever upon us, and before Whom even I am but a crushed worm?" And the page-boy says: "The missus, my Lord." (Laughter.) I am afraid that the Treasury is our "Missus" in this regard. However, in spite of the restraining eye of the "Missus," I am glad to think you are able to make considerable strides in the direction of the extension of the telegraphs and telephone lines and wires. (Applause.) I doubt if it is appreciated

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outside, the enormous extent of the work carried on by the Engineering Department of the Post Office, because I find that in the last twelve months no less than 123,000 miles of telegraph or telephone wires were laid in this small island of England, and that, of course, includes Scotland. (Laughter.) That, I think, shows the great work that you are undertaking. (Applause.) Of course, most of that is telephone work.

There is one further matter on which I should like to congratulate Major O'Meara, whose presence in the Chair this evening we all much appreciate, and that is the great success which, I understand, is following the Institution of Post Office Electrical Engineers under the auspices of the Engineering Department. That, I think, is a really great step, and it is already founded on a very sound basis. And it seems, as far as one can judge, that it will be of very great advantage to the Engineering Department as a whole. (Applause.) The number of members is already great, and Foreign and Colonial members are now asking to join. One thing about it is that, like so many Post Office Associations of that description, while it is assisted to a certain extent from headquarters, it is entirely self-managed and practically self-supporting, and is run by those who are really interested in the matter. (Applause.) That is the only way in which an institute of that sort is likely to be a success.

I have to give you "The Engineering Department." I take it that nine tenths of you belong to the Engineering Department, and therefore, when I give you that toast you must not receive it with cheers, as that would only be a sort of self-praise. (Laughter.) I see one or two of us who are not members—like the Secretary, Mr. King, and others—and to them I give the toast with the greatest possible pleasure and gratification. I give to them the toast of the "Engineering Department." As far as we are concerned we will drink it with all the honours, because we feel that the Engineering Department of the Post Office is not only a great credit to the Post Office, but also to the nation at large. (Loud applause.)

Major O'MEARA, responding to the toast of "Engineering Department," said:

Mr. Buxton and Gentlemen: We had hoped to have had Sir William Preece with us this evening. Unfortunately this morning I received a letter from him in which he says: "I am very sorry to say I cannot come to the Dinner to-morrow night. I am just recovering from a very bad chill, and my doctor forbids my going out this week." On behalf of the Engineering Department I have to thank you, Mr. Sydney Buxton, for the very kindly manner in which you have proposed the toast of the evening. I feel sure that my colleagues very much appreciate the very kind words in which you have proposed this toast, words which afford us very much

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encouragement, coming as they do from the great Chief of a very great Department. We also appreciate, sir, the fact that, with all the calls on your time, you have paid us a very great compliment by being with us this evening. (Applause.)

These annual gatherings have offered opportunities for reviewing the work done by the Department. Last year our gathering was something more than a family party. Prominent people connected with our profession seized the opportunity and made it an occasion to do honour to a retiring chief, whom we are very glad to see with us to-night. (Applause.) I am sure that the announcement that the Postmaster-General has been pleased to make, that Sir John Gavey is still going to have an active interest in our work, and is going to place his very large and varied experience at our disposal, has given you all very great pleasure. (Hear, hear, and applause.) When last we met as a family party last year we were not able to discuss our domestic affairs. The phenomenal growth which has been referred to at these meetings has been continued. What has been referred to as the great transfer is still the great problem which has to be tackled by us. Our appetite has been slightly whetted since our last annual dinner, for we have already swallowed up the municipal undertakings in Glasgow and Brighton. The Postmaster-General has told us of his dealings with the Treasury. And I think it only shows that he has got some of the qualities of my own countrymen—persuasive eloquence. For he has succeeded in getting funds, and he has been able to do a great deal, not only in the matter of telephonic development, but also in providing for the extension of the underground schemes in which we have been so interested during the last few years. A great deal has been done in Scotland, the North of England, and in the West in order to provide the necessary security during storms in regard to our telegraphs. In the period which has passed, of course, we have had also to carry out the trial and examination of many new inventions. The course of progress of our service and the protection of the public purse depends very largely on the care and thoroughness with which this duty is carried out, and also upon the correctness of the conclusions which are drawn from the practical trials which take place. I think that those who know something of the inner working of our Department are quite prepared to acknowledge that it is due to the successful manner in which our engineers have carried out these duties, coupled with their own inventive genius, that the British Telegraph Service to-day is acknowledged throughout the world to occupy the premier position. (Applause.) In matters telephonic our cousins across the millpond are supposed to take the lead. Well, gentlemen, we all acknowledge that we owe a great deal to our cousins, but we also feel that our engineers have not been content to be simply followers. They

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themselves have in matters telephonic also exerted their ingenuity, and there are many devices in use to-day in this country which have been devised by our own engineers, which certainly do very much to improve the telephonic communication and at the same time cheapen the cost of the service. When I enter one of our large telephone exchanges or even one of our repeater stations, I often picture the different stages in which I have seen ideas which finally have produced the mechanism which our colleagues in the operating department are employing to so regularly and smoothly deal with the traffic. On these occasions I am reminded of Owen Meredith's lines :

> "Not a truth has to art or to science been given,
> But brows have ached for it, and souls toiled and striven."

It is on these occasions that the truth of these lines, as applying to the work of our own engineers, come sharply home to me.

We all recognise that the Postmaster-General, as he has told us this evening, is desirous that our telephone undertakings shall be carried out on commercial lines. There are many of you present here to-night who I know have studied the commercial aspect of this question, and that you have studied this question with a certain amount of success I know is true. I am ready to say myself from what I see that your investigations are producing very valuable results. I can tell you this from the fewer demands that I have for additional maintenance staffs. Well, gentlemen, I fear that there are small grounds for anticipating in the coming year that our engineers will be less busy than in the present year. I do not think we shall have much time for meditative exercises. We still have, of course, a great deal of work to carry out in connection with telephone trunks and telephone exchanges. Heeltaps on the 31st March will amount to something over £850,000. We have to carry out the completion of the Western underground. I think by the end of the next financial year we ought to reach the cable landing places near Penzance. And the Postmaster-General has promised the good people in the North that he will proceed with the underground between Newcastle and Leeds. But we have received authority this year to do something more than that. The Postmaster-General has decided to link the old northern route and the new western route, and the first sod has been cut in a length of underground line from Bristol to Worcester. I do not think it requires me to be much of a prophet to suggest that some further work is likely to be authorised in that direction during the next year. The Postmaster-General has referred to wireless telegraphy. Of course, you all know that on the 1st July, if the British Government adheres to the International Radio-Telegraph Convention, new duties and responsi-

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bilities will be thrown on the Post Office. As the Postmaster-General has told us, some share of these duties will certainly fall to the lot of our engineers. Now I come to a matter of personal moment to you all. During the past few months many changes have taken place. I am glad that some of them have distinctly improved your prospects. By the recent revisions and changes there has been an increase in the establishment, of higher appointments both on the engineering and clerical sides. I know there has been a rumour afloat for some time past that a great scheme of devolution is going to be carried out. I have no particular information on this point which is not open to the man in the street. I feel sure that none of you will shirk any additional responsibilities; in fact, I feel sure that you will welcome any additional responsibilities which may be placed upon you in connection with the devolution scheme, and that you will make any such scheme a very great success. We are not quite unprepared for some change of this kind, for in 1904 a reorganisation scheme was carried out which had devolution in view to a certain extent. I have been looking into the working of that scheme, and I may say that from most quarters I learn that people are satisfied with the scheme. It is a scheme which is likely to be a very successful one, and I think we can go one better. In 1904 we had first-class sections and second-class sections. My recent investigations, I think, show that we can get rid of some of the second-class sections, in fact—get rid of them all. I think we can afford to have only first-class sections. What that will mean to most of you I do not think I need say. I have expressed confidence in the successful issue of any devolution scheme, for I know how whole-heartedly the members of my own staff and those of the districts will apply themselves to any scheme which may be placed before them. I think there is plenty of evidence to show that there is quite sufficient *esprit de corps* to make any scheme a success. If any further evidence is necessary, I can only refer to the fact that at our first annual dinner Sir John Gavey offered us some valuable advice, pointing out that the demands of the future make it necessary that we should acquire the highest possible technical and scientific knowledge. The idea was taken up at once, and as a result we have to-day the Post Office Institute of Electrical Engineers, to which the Postmaster-General has referred. I think it must be very gratifying to all those who have taken such an interest in the birth and nursing of this Institute, to find that the educational work of this Institute, although it is only in its second session, is so widely recognised. I must say I should very much welcome the addition of honorary members to our ordinary membership, and I think we shall be doing an imperial work, for I think that the accession of

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honorary members will be only the addition of another of those silken cords which bind our empire together. In connection with our Institute we are now going to have a journal. I think that the scope of the Institute is very clearly shown by the circular issued showing the many subjects under which those who will do so can contribute articles to help forward the success of this journal. In addition to the educational value, I have no hesitation in saying that the existence of the Institution plays a very important part in fostering feelings of good fellowship. The Postmaster-General has remarked that in a big service like ours there is a great deal of good comes from our meeting one another. I have for a long time felt that all those who have to work together should play together. Of course, in a big city such as this we are compelled to live widely scattered. We have to hurry up by an early train to get to our work, and then in the evening we dribble away as each one is released from his work. We cannot march away together like an army. We have not that opportunity of social intercourse which is provided in many other callings This matter of playing together was brought home to me many years ago. I was with the Post Office at the time. I had to call on an old gentleman, one of the old school. He gave me what I asked for—a consent for poles, and then he gave me some advice. I may say I have always felt grateful for the advice given on that occasion. He told me he had a partner, and he said: "During the week I am afraid we jangle a bit; can't help it. But ever since my partner and I have been associated together we have made it a practice every week-end in our life to go away out of town together to wipe away the jangles, and begin with a clean slate on Monday morning." Well, I often feel that we ought to be able to do this too, but we are a very large family with many partners, and there are not many hotels that would accommodate us if we left our work in that way. Now, in connection with the Institute, I have a very strong hope that some day the Institute and these dinners will pave the way to the foundation of a club where we can meet together, and where not only officers stationed in the provinces may meet those doing duty in London, but where, also, officers may come who have retired from the service. I think that in this way feelings of brotherhood in our grand service will be strengthened, and I think it is only right that this should be so in the service which does so much to promote good understanding between individuals and nations. Well, gentlemen, I can only say we thank the Postmaster-General for the very kindly way in which he has proposed this toast and our friends for the very hearty manner in which they have received it.

Mr. NOBLE, in proposing the toast of "The Visitors," said:

We are pleased particularly to have with us the Postmaster-

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General. We fully appreciate the inconvenience and sacrifice the Postmaster-General has made to spare an evening during the pressure of a Parliamentary Session, more particularly as we are aware there is an unprecedented amount of administrative work at the General Post Office.

We are very pleased to-night to have an ever-welcome guest in Sir John Cameron Lamb. (Applause.) Sir John was always known as the friend of the telegraphs, and I am sure that he will be pleased to know that since his retirement it has been abundantly proved that he left behind him two other very good friends of the telegraphs—Mr. King and Mr. Carey. Gentlemen, the telegraphs have a younger, robust, and rapidly-developing sister in the telephones, and here, again, the Department is fortunate in having at its head another able officer, Mr. Ogilvie, who is also with us this evening. (Applause.)

There is only one other name that I have to mention, and although I mention it last it is by no means the least. I refer to our Secretary, Mr. Babington Smith. (Applause.) I have left his name to the last because it has been our privilege each year to couple his name with the toast of the guests. Mr. Babington Smith's qualities and qualifications are too well known for me to mention them; indeed, it would be unbecoming of me to do so. They are known wherever the Postal Union extends. As an engineer, however, I may be allowed to say how proud we engineers were to hear of the high reputation he gained for himself at the International Wireless Convention.

Before sitting down I should like to say, although it is no part of my toast, that we are pleased with the suggestion of the Chairman that we might form a Club. We all feel that it is not sufficient to meet socially once a year, and the idea of a club is a good one. It has been suggested to me by a friend on my right that we might include the officers of the National Telephone Company, and I think this, too, is a good suggestion, as we might in this way get some useful information. (Laughter.) Gentlemen, in the name of the Engineering Department I ask you to be upstanding, and coupling with the toast the name of Mr. Babington Smith, drink to our guests.

Mr. BABINGTON SMITH, in reply to the toast of "The Visitors," said:

A serious responsibility always lies upon the person who has to return thanks on behalf of "The Visitors," in that he has to represent a large company of distinguished persons. I think I shall best discharge that responsibility if, on behalf of every one of them, I thank you very cordially for your kindness in inviting us to take part in your dinner this evening, for the terms in which this toast has been proposed, and for the hearty way in which it has been received. (Applause.) I should just like to add a few words of thanks on my own behalf to Mr. Noble for the very kind way in which

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he spoke of myself. It is a very great pleasure for all of us to be here this evening, and to be able to take this occasion of welcoming your Chairman at the first dinner of the Engineering Department over which he has presided as Engineer-in-Chief. (Applause.)

Gentlemen, among your guests you have the producers of raw material for your work in the representatives of the factories and the stores. You have also representatives of the branches of the service that may be described as your consumers—branches which use the material that you provide—and looking at the Engineering Department as the indispensable link between these parts of the great machine of the Post Office, I think it is, perhaps, not too much to say that it is the most indispensable part of the machine. (Applause.)

I can imagine very easily someone saying that the Telegraph and Telephone service could go on very well without a Secretary. (Laughter.) I can even conceive somebody suggesting that the machine would continue to work—if I may be permitted to whisper such a heresy—without a Postmaster-General. (Laughter.) But it cannot get on without wires and instruments and without an Engineering Department to erect and maintain them. (Cheers.) I think, therefore, I am not far wrong in regarding your service as perhaps the most indispensable part of the whole Post Office machine, and as that indispensable part we naturally expect great things of you. (Hear, hear.) We are all endeavouring to carry on the great service of which we form part on efficient, economical, and commercial lines. To give one instance only, the Postmaster-General has mentioned the question of telephone rates which is engaging much of his attention at present. For the solution of that question, or of any other question of that nature, and I think I may say for all questions affecting the proper development and conduct of the service, one of the prime necessities is a full, precise, and accurate knowledge of the cost of each operation. (Hear, hear.)

Steps have been taken and are still being taken by the Engineer-in-Chief to provide machinery for arriving at fuller information on these points. I fully understand that the work thus thrown upon engineers may not be congenial, since their heart is naturally and properly in what they regard as their own proper work. Still, I feel sure that the Service realises that the accounting side has its great importance too, and that in that, as in all other respects, we can rely on the engineering service performing the functions that are entrusted to it with the same zeal and the same efficiency which it has always shown in the past. Gentlemen, I will only conclude by wishing success and prosperity to the Engineering Service, and success and prosperity to everyone of you individually, and may each one of you in due course rise to be Engineer-in-Chief. (Loud applause.)

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Mr. H. R. KEMPE, who was received with loud and prolonged applause, in rising to propose the toast of "The Chairman," said:

I have very great pleasure in proposing the toast of our Chairman.

Major O'Meara has always taken the very greatest interest in matters, not only which concern the Department as a great State institution, but also in all matters which concern the interests of the staff under his command. The German philosopher Sulzer has stated that pliability without firmness is weakness, but firmness without pliability is foolishness, and, indeed, is stupid obstinacy. I feel that Major O'Meara has made that saying one of his guiding principles, for while he has always shown that firmness which is so necessary in order to control a large department, he has at the same time shown that tactful pliability without which the smooth and harmonious working of the department is quite impossible. (Applause.)

Major O'Meara on more than one occasion has expressed his desire that all members of the staff should, as far as possible, see eye to eye with him. If each individual member of the staff had such a personal knowledge of him as I have the pleasure of having, I feel sure they would do all they possibly could to further his wishes in that respect, and, further, that they would take him as an example of what a hard worker and one devoted to the Service should be. By continual and constant attention at all our meetings, whether it be a meeting in which Departmental matters alone are discussed, as, for example, the meeting of Superintending Engineers, or on a semi-official occasion, such as that of our Institution of Post Office Electrical Engineers, or of a social character such as, for example, our Chess Club, Major O'Meara has, except when he has been called away by official duty, never failed to attend, and in this respect I think we owe him our esteem and admiration.

Gentlemen, the toast is our Chairman.

Major O'MEARA, in replying to the toast of "The Chairman," said:

I have been very much touched by the kind words that our dear friend Kempe used in proposing the toast of myself. I feel, gentlemen, that it must have been my destiny to come to the Post Office. I can remember it was nearly twenty years ago when I first came to the Post Office. It may be interesting for you to know, perhaps, the conditions under which I came to the Post Office. I was a young subaltern then, stationed at Portsmouth. I was very much interested in military matters. I did not think of anything else at that time. I had gone away to Germany to go over the battlefields of Napoleon, and, apparently, whilst I was abroad my colonel wrote to me, asking whether I would like to go to the Post Office telegraphs. Well, I was travelling about, and that letter did

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not reach me. I got back to my head-quarters, and I found waiting for me a communication from the Commandant at Sandhurst offering me the position of instructor at the Military College. At that time I was very anxious to go to the Staff College. My duties in some respects put me in a position similar to that in which you find yourselves. I had no time for study. I felt that, holding an instructorship, I should be learning something myself whilst teaching my pupils. I wrote to the Commandant saying I would call on him. Meantime I got a letter from my Colonel saying that he had sent me a communication to Germany, asking whether I would go to the Post Office telegraphs, and that he had received no reply from me. I did not know what to do; I found it difficult to choose between this instructorship and the Post Office telegraphs. Well, I knew there was an officer in the Command who knew something about the Post Office telegraphs, and I went to him and told him I did not know what to do. I had the offer of two appointments, which does not often happen to young men. I had been asked to go to Sandhurst and I had been asked to go to the Post Office. "Are you thinking of getting married?" he said. "If so, go to Sandhurst; if not, go to the Post Office." (Laughter.) I have often thanked my lucky stars that I was not thinking of getting married, and that I went into the Post Office. And I may say that in my career after I left the Post Office I have felt grateful for the experience I had had in the Post Office. That is the first occasion on which I came to the Post Office. On a later occasion, six years ago, I was in this country temporarily on leave. My leave was very much prolonged because I was asked to carry out some duties for the Government under which I was employed at that time, and that had a very fortunate result for me. Finally, the business I had to carry out was finished. I had gone into the Union Steamship Company's office and bought a ticket for South Africa. That was at one o'clock. At two o'clock my train was due to leave Waterloo Station. On my way there I came across the Consulting Engineer of the Post Office. He said: "What are you doing?" I replied: "I am going back to South Africa." He then said: "There is an appointment vacant at the Post Office which we want you to take. Haven't you heard about it?" I replied that I had not heard about the vacancy. Sir William Preece then requested me to postpone my journey, and see him again at four o'clock that day. I did so, and that is the reason why I am here to-night.

Gentlemen, I must say I have to thank you heartily for the very kind way in which you have supported me this evening. I do not think I need repeat how very much I have the interest of you all at heart, and I think you may rely on me to do the best for you all. (Applause.)

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OBITUARY.

THERE died at 3, Southwood Avenue, Highgate, N., on Monday, February 17th, 1908, William Robson Smith, retired Post Office Electrical Engineer, at the age of 56 years. It is with great regret that we have to make the above announcement. Mr. Smith was born in Elgin, N.B. Early in life he started upon his travels as a journeyman watchmaker, in search of his fortune. He reached Newcastle-upon-Tyne in 1872, a modest young man with an apparently impassive countenance. He was given employment in the mechanician's shop of the Postal Telegraph Department. Having obtained a foothold he set to work to acquire electrical knowledge, and by sheer merit won the foreman's position in the workshop, which he reorganised.

As one of the pupils of Mr. A. W. Heaviside (then the lecturer to the City and Guilds Institute) he won the Silver Medal for Electricity, Magnetism, and Telegraphy. Eventually he became a lecturer himself under the City and Guilds Institute. Steam and pneumatics were then added to his studies.

In May, 1877, he and a colleague, always seeking knowledge, made, from a description in the 'English Mechanic,' perhaps the first telephone made in Great Britain. From that time forward, for many years, he became one, of two, of Mr. A. W. Heaviside's ablest assistants in pioneer practical telephony, firstly amongst switches and apparatus, and secondly as Engineer-in-Charge of the Newcastle exchange and the west section of the Newcastle district.

Later his ability carried him to London to become Engineer-in-Charge of the Central Telegraph Office, with its batteries, telegraphs, chronopher, engines, and pneumatic systems. Here his organising ability was shown to advantage, and also his mechanical skill. He redesigned the pneumatic valves, introduced an important improvement in the Pneumatic Tube Signaller, and carried out the rearrangement of the terminations of the main tubes in the Central Telegraph Office which brought them to their existing state. He also carried out the entire re-wiring of the Central Telegraph Office. This involved the removal of an enormous accumulation of gutta-percha-covered wire and its replacement by lead-covered cable. This difficult work was carried through entirely without interruption to the ordinary traffic.

Lastly, when the Post Office took up the telephone in earnest he was associated with that work in a very active manner, and became Assistant Superintending Engineer in the Central District, London.

His health failed in 1901, when he retired. Only his intimates knew and appreciated his merit as an engineer, a shy manner hiding an ability to design and to do things which were quite above the average.

A. W. H.

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JOHN HENRY CORDEAUX.

We much regret to have to record the death, at the age of 66, of Mr. John Henry Cordeaux, late of the Postal Telegraph Department. Mr. Cordeaux, whose name is well known in connection with the "Screw Insulator," devised and patented by him, and which is almost universally used in the United Kingdom and also largely elsewhere, was born in 1841. In 1854 he entered the service of the Electric and International Telegraph Co., and was for a long period stationed at York. In 1870 he was appointed, on the transfer of the telegraphs of the United Kingdom to the State, as Inspector in the Engineering Department, at Birmingham, under the late Mr. E. Graves, in which capacity he devised the screw insulator. In 1878 he was transferred to the Engineer-in-Chief's Office, London, under Mr. W. H. Preece (now Sir W. H. Preece, K.C.B.). In 1883 he was promoted to the position of 1st Class Technical Officer, and subsequently, in 1898, became Acting Principal Technical Officer. In 1898, owing to ill health, Mr. Cordeaux retired from the Service, to the great regret of those with whom he had been so long associated. By Mr. Cordeaux's death another link of the very few remaining which connect the days of the old Telegraph Companies with the present State system, has gone. H. R. K.

The closeness of past friendship with Mr. Cordeaux makes me welcome an opportunity of paying a last tribute of love and respect to one whose kindliness of heart was always level with his business capacity. J. H. Cordeaux was, I believe, the "straightest" man I ever knew. This, in spite of the fact that he seemed to be almost entirely devoid of any religious instinct, which is *the* factor that keeps so many of us from being very wanting in this important virtue. Those who knew him at his prime remember him as constitutionally impetuous and impatient in his manner by sheer force of energy; and it was a revelation, when his painful illness had at last got the mastery of his body, to find him the most patient of invalids, the least exacting, and the most considerate.

The death of his wife left him the sole care of his two daughters, and he set himself to the task with a devotion that, while it secured an answering love and devotion from them, also increased the loving esteem in which he was held by those who were privileged to be counted among his friends.

Now that after years of suffering, heroically borne, he has passed away, rightly and right lovingly may we say for him, "*Requiescat in pace.*" A. J. S.

COMMUNICATIONS.

All communications should be addressed to THE MANAGING EDITOR, 'P. O. E. E. Journal,' 22, G.P.O. West, London, E.C.

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SOME OF THE ENGINEERING STAFF, IRISH DISTRICTS.

Front row: (1) W. M. Evans, (2) J. Sheridan, (3) A. Moir, (4) W. H. Cross.
Second row: (5) G. Henshilwood, (6) A. T. Kinsey, (7) E. J. Hammond, (8) W. Pennington, (9) W. F. Humphries, (10) J. McCarthy, (11) J. H. Fossett.
Third row: (12) J. H. Shaw, (13) A. E. Dawson, (14) R. A. Weaver, (15) W. Golding, (16) T. Patterson, (17) J. Davidson, (18) T. McDonough, (19) J. J. Dwyer.
Fourth row: (20) G. T. Fisher, (21) H. S. Bell, (22) H. Doak.

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THE
Post Office Electrical Engineers' Journal.

NOTES AND COMMENTS.

Examinations.

It is a good plan, when a subject comes into special prominence in connection with our life or our work, to carefully and critically examine its bearing thereon, and determine what shall be our mental attitude towards it.

We propose to do this in connection with the subject of "Examinations," because we feel sure this word has, of late, been more frequently in the minds of Post Office Engineers than any other in the dictionary.

But first we must differentiate; two kinds of examinations engage attention at present:

(*a*) Examinations within the Department for promotions to Sub-Engineerships, Engineerships, and Staff Engineerships.

(*b*) Examinations of university nominees for admission into the Service as *Engineers*.

Dealing with (*a*) let us first ask, Are such examinations necessary? and we reply that if we have to choose between a system of promotion by *seniority*, which neglects merit and stifles ambition, or a system of *selection*, which admits of grave abuses, examinations offer a third alternative, or rather, let us say, an additional aid, which every thinking man must welcome.

We can conceive no better system of promotion than one in which due weight is given to seniority (which means experience), to special fitness, as shown by past work, and to qualifications proved by examination.

We have deliberately placed examinations in the third place, below experience and special fitness, because examinations give no indication whatever as to character, which is all important, nor do they indicate with any degree of certainty a man's capacity for doing practical work, while they unduly favour the man who is fresh from study at the expense of his more experienced colleague.

In this connection, however, we rule out *competitive* examinations among established officers, for what chance would the capable

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engineer of ripe experience have in competition with a young man fresh from the arena of examinations?

We hope we are right in believing that the old system—under which an insignificant majority of marks obtained at an examination, overbalanced years of experience, higher rank, and proved ability—is for ever abolished.

We are strongly of opinion that all such examinations should be *qualifying*, applied, not as tests of fitness, but of unfitness. An ideal system would avoid multiplication of examinations, and would provide for another point of special importance, viz. that the final examination *qualifying* for staff rank should not be deferred till a late period in life.

Aspirants might be given the opportunity of undertaking the examination before the age of thirty, or possibly thirty-five, and gaining a certificate which would render them *eligible* for promotion to a staff appointment.

We are pleased to think that the arrival of the Selection Committee which has, during the past month, been examining second class engineers for higher appointments, is an indication that a very earnest attempt is being made to select the right men for high positions, a result which, if achieved, can only benefit all concerned.

With regard to (*b*) such outside competitive examinations may secure men with high educational qualifications, but their entrance is followed by a long period of service unremunerative to the Department, and it is open to question whether men so helped along will serve the Department better than those who, while passing through lower grades, have fully equipped themselves for higher appointments.

In this connection Major O'Meara's article, which deserves careful study on the part of our readers, is very welcome, and the phrase readily rises to the mind, "They do these things better in France." We hope the account of the French system will turn attention in this country to the possibility of founding a State school to train telegraph and telephone engineers for the Empire, a school in which students recruited from the Staff and from outside could obtain a thorough theoretical and practical training.

Sir W. H. Preece, K.C.B., F.R.S.

We are sure our readers will learn with sincere regret that Sir W. H. Preece has been very seriously ill and has not therefore been able to contribute to this number his promised article on "Pre-Post Office Telegraphs." We are pleased to know that his condition is improving, and we wish him a speedy return to good health. He has been good enough to send through Mr. Llewellyn Preece an assurance that he will proceed with the writing of the article as soon as he is sufficiently recovered.

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Finance.

The control of expenditure is a subject which, it is needless to say, is of the highest importance; at the same time it is one about which much diversity of opinion must exist, not only from the difference in the trains of reasoning by which deductions are arrived at, but also from the great difficulty of obtaining accurate facts upon which to base the deductions. Expenditure obviously has to be kept within limits, otherwise financial embarrassment is bound to be the ultimate outcome of such limits being overstepped. Frequently the cutting-down process is, we imagine, more a matter of chance than of anything else. Amounts are asked for for carrying out desirable works, but the controlling department, being pressed by the higher powers, has no option but to apply the pruning knife irrespective of what the result may be, *i. e.* as to whether the refusal, or the diminution, of an amount asked for may not result in a most uneconomical carrying out of the original object. Such a result is not only conceivable, but does actually take place, and until finance becomes—if such a thing is possible—an exact science, it will again and again recur.

System in keeping accounts, although it cannot ensure economy, goes far towards it, inasmuch as it indicates, or ought to indicate, in a plain manner how expenditure is being conducted, and whether a due proportion of the various items making up the whole is being arranged for.

How far elaboration of accounts is logically advisable seems to be a matter upon which no just conclusion can be arrived at; in many cases much expenditure of time, and consequently of money, takes place without any use being made of the statistics obtained; the latter are often filed away in pigeon holes, are perhaps forgotten, or if they are published they are merely looked at and the remark passed that "they are very interesting," and there the matter ends. The clerks who compiled them are paid their salaries, which enable them to keep their wives and families in more or less comfort, which doubtless is a good thing, but whether the community is the better for money so expended is rather doubtful.

In the lecture abstract on "Army Finance" by Mr. Charles Harris, which we give elsewhere, a careful analysis of general accounting is given, and while the matter is "very interesting," it is, we think, something much more than this, as it affords a close insight into the general principles of government finance put in a very plain and clear way; the criticism is at the same time outspoken, as, for instance, when the statement is made that "army accounts afford no indication whether administration is economical or not," also the phrase "financial responsibility" is often used to denote simply the power to spend public money unquestioned.

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Types of Underground Cable.

Elsewhere will be found an account of the general questions to be considered in the design of lead-covered paper-insulated cables for telegraph and telephone purposes. When a cable contains conductors for both these services the insulated telegraph wires, particularly when long lengths are involved, are provided with a spiral lapping of copper tape to act as a screen against excessive induction between one wire and another.

So long as the insulation resistances of the conductors remain high and equal there is no interference between the screened telegraph circuits and the telephonic unscreened loops.

Screened telegraph wires are almost invariably arranged in layers outside the telephonic loop portion of the cable so as to be in contact with the lead sheath and make good contact with "earth."

The simplest arrangement of *loops* or *pairs* is that adopted in the formation of the *twin* type of cable, in which the individual pairs are stranded directly together. Such a type of cable is especially suitable for use where each pair of wires is wholly given up for a separate circuit. In exceptional instances—for example, the case of subscribers' circuits up to about five miles in length connected with common battery exchanges—where it is desired to arrange a loop of lower resistance than that of a pair of wires, two pairs may be given up to form one circuit by bunching two "a" and two "b" wires respectively, but this procedure, *it must be clearly noted*, is only possible with full advantage in the circumstances above mentioned for the reason that the capacity of the system is doubled by the bunching, and as the circuit is lengthened the evils of the additional capacity become noticeable. Superimposed circuit working is practically impossible with the *twin* type of cable for the reason that the limbs of any *plus* circuits would be virtually parallel with each other.

Superimposed working is so commonly resorted to that for the underground sections of trunk routes it is necessary to use a form of cable in which the pairs are arranged in groups. In these groups the pairs are so disposed that each two, or multiple of two, revolve about a common centre. This object is attained in both the *multiple twin* and *quad pair* forms of cable. In the multiple twin type each pair of insulated wires is twisted with another similar pair to form a 4-wire core, such that by using the *a* and *b* wires of each pair as a single conductor, a pair is formed of which the conductor weight per mile is twice that of the wires forming the component pairs. The process may be further continued, and one set of four wires be twisted with another similar 4-wire core, but for general purposes the simple construction of two-pair cores meets all requirements. The capacity per mile between one pair and another in this type of

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cable is from 25 to 50 per cent. greater than between one wire and another in a single pair, depending upon the tightness with which the wires are packed in the cable.

In the quad-pair cable four simple pairs are stranded about a centre of yarn, the presence of the latter being essential as a means of ensuring that the four pairs shall occupy positions as nearly as possible symmetrical about the centre, *i. e.* at the corners of a square. If required, four smaller pairs of wires may be stranded in the respective interstices between the larger pairs of which the quad core is made up. A number of such cores are then stranded together. In this form of cable it is diagonal pairs of wires which are used for superimposed working or for making up circuits of conductor weight double that of a component pair. The capacity between pair and pair may be equal to, or 25 per cent. greater than, that between the two wires of a simple pair, according as the conductors are loosely or tightly packed in the cable. The conductor resistance is, of course, halved by bunching.

It will be seen that for a given wire-to-wire capacity of the simple pairs in multiple-twin and quad-pair cables respectively, the latter has the advantage, in that by bunching the conductors the capacity is not increased to quite the same extent as in the multiple-twin type, where a minimum increase of 25 per cent. takes place. Considered, however, from the point of view of the number of simple pairs of given capacity which may be formed into a cable of given size, the multiple-twin type has the advantage, owing to the fact that the space taken up by four pairs in the quad-pair is at least 30 per cent. greater than in the multiple-twin form.

It is, therefore, a matter for consideration whether it is better to provide (*a*) fewer quad-pair circuits with a given capacity on both simple pairs and an equal or slightly increased capacity on superimposed circuits, or (*b*) multiple-twin cable with a *greater number of pairs*, having a capacity the same as the simple circuits in the quad-pair cable and a capacity on the superimposed circuits 25 to 50 per cent. greater than that of a simple pair. One other point in favour of multiple-twin is that, for a given number of wires in a given space (owing to the absence of yarn) the cable is slightly more flexible than the quad-pair type, and desiccation is easier.

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EDUCATION AND TRAINING OF TELEGRAPH ENGINEERS IN FRANCE.

By Major W. A. J. Omeara, C.M.G.

The appearance on the scene of 'The Post Office Electrical Engineers' Journal' cannot but be regarded as a sign of the healthy activity of the members of a great public service, and it is indeed a matter for sincere congratulation that the engineers of the British Post Office now possess a publication which will enable matters of particular interest to them to be brought to notice in a readily accessible form.

Although my inaugural address at the opening of the second session of the Institution of Post Office Electrical Engineers, in October last, dealt with the training of the telegraph engineer, and Sir John Gavey has also very recently read a paper on "The Education and Training of the Engineer," there is much to indicate that the topic is one which still continues to afford considerable interest to many readers of this Journal. This, I think, was clearly shown by the discussion which followed the reading of Sir John Gavey's paper on the occasion just referred to, when I was unfortunately guilty of a breach of the rule laid down that no speaker, after the first one, was to occupy more than five minutes of the time of certainly a very patient audience.

In the time at my disposal I was able to touch only on the fringe of the points raised in the discussion, and I failed, therefore, to deal with the important question raised by one of the speakers taking part in the discussion, who stated that a great deal had been said concerning the general lines on which the education and training of a telegraph engineer should proceed, but that no indication had been given in precise terms of the subjects, and their scope, which should engage the attention of the telegraph engineer desirous of success in his profession. It is in the hope of filling up this blank that I undertake my present task.

The subject is naturally one which has engaged much of my attention, and more particularly so as the question has also been before the Civil Service Commissioners for some little time. I have had to give consideration to the subject from the two points of view of:

(1) What shall be the subjects of examination, and the standard in each subject, for entrance into the Engineering Department of the Post Office? And—

(2) What can the Civil Service Commissioners reasonably require as a proof of their abilities from officers, already in the service, before

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the latter may be recommended for promotion to Staff rank by the Engineer-in-Chief?

It may serve a useful purpose if I state the manner in which the investigation of the subject was approached by me. First, then, I felt that it was possible to draw a distinction between the examinations proposed. In the one case the question for consideration was:—What is a suitable foundation in theoretical knowledge for the telegraph engineer to start with, which will not only support the structure of practical engineering knowledge which satisfies present-day practice, but which will also prove to be one capable of standing the test of time and thus provide a margin to meet any modifications which may be dictated by later-day requirements? In the second case, the question seemed to me to resolve itself into one concerning the value of the structure of engineering knowledge built by practical experience on a foundation laid many years ago.

I do not propose to touch upon the second question in this article, for the Civil Service Commissioners have recently issued the scheme of examination for promotion to Staff rank, and the Post-master-General's decision on the subject has been promulgated in the Engineer-in-Chief's monthly circular for April last.

In examining the question of the qualifications which should be expected from new entrants into the Engineering ranks, both in the case of those officers who are already in the Post Office service as well as in the case of those who may be drawn from some other source, I felt that the subjects for examination and the standard fixed should be chosen in relation to the scope and character of the duties of the engineers engaged on executive duties. It was not difficult to decide, in the abstract, that the subjects for examination should be chosen with a view to providing new entrants with knowledge of a kind which, after a short practical training, should enable them to perform their duties intelligently and efficiently. But I recognised that it was a more difficult matter to decide on the standard in each subject which it was desirable that the embryo telegraph engineer should have acquired before appointment to engineering rank. I felt that reliance on my own personal experience alone might tend to the creation of an arbitrary standard in my mind, and, in consequence, I decided that it would be safer, before adopting a standard for my own guidance, for me to examine the curriculum adopted for the education of telegraph engineers of the Indian Service, and also the courses of instruction laid down for the engineers in the telegraph services of France and Germany.

Since I commenced the study of this subject the abolition of the Royal Indian Engineering College at Cooper's Hill has been decided upon, and I am not yet in possession of information as to the method by which the Government of India proposes to obtain its telegraph

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engineers in future. Under these circumstances I have felt that it would be better to postpone reference to the course of instruction at Cooper's Hill for the present. I therefore propose to deal, in the first instance, with the training provided for telegraph engineers in France.

The scheme for recruiting engineers for the Telegraph Service in France cannot fail to be of immense interest to us, and as my old friend, M. Thomas, the Director of the Ecole Professionelle Supérieure des Postes et des Télégraphes, has very kindly furnished me with some particulars regarding the programme of instruction carried out in the Institution under his charge, I propose to place the same before the readers of the JOURNAL.

The engineers for the French Telegraph Service are drawn from two sources :

(*a*) Officials of the postal and telegraph branches of the P.O. service.

(*b*) Candidates having certain qualifications who are not connected with the Postal Administration.

Officers obtained from both sources have to undergo a course of instruction of two years' duration at the École Professionelle Supérieure des Postes et des Télégraphes.

Officers of the Postal Administration desiring to become engineers have to compete at an examination for admission into the École Professionelle ; they are nominated as candidates if they hold a good service record and are well reported upon by their superior officers. They must possess at least two years' effective service, and must be under thirty years of age on January 1st of the year in which the examination takes place ; the entrance examinations are held once in every two years. The candidates have to undergo written and oral examinations in the following subjects :

Written Portion.

Mathematics	4 hours.
Mechanics	4 „
Physics and Chemistry	4 „
Drawing	3 „

Oral Portion.

Mathematics.
Mechanics.
Physics.
Chemistry.
Modern language (English or German).
Second modern language (other than English or German).

The details of the subjects of examination are given in Appendix I.

No candidate is allowed to take part in the oral portion of the examination unless he has first satisfied the examiners in the written portion of the

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examination. Bad spelling also disqualifies a candidate. The positions of the candidates on the competitive list are determined by the total number of marks obtained in the two portions of the examination. The subjects mentioned above, except the modern languages, are all compulsory. The whole of the marks obtained in each subject are counted for placing, with the exception that in the case of the modern languages marks equal to 60 per cent. allotted to these subjects are first deducted from those obtained, and the balances only are credited to the candidate.

Candidates for engineerships, who are not already serving in the Postal Administration, must have satisfied the requirements of the French law regarding military service, and must be less than twenty-six years of age on January 1st of the year in which they join the École Professionelle. Their applications for admission to the School are addressed to the Under-Secretary of State for Posts and Telegraphs, and must be accompanied by:

(1) Birth certificate, and, if necessary, letters of naturalisation.

(2) Certificate of good moral character.

(3) Extract from sheet relating to offences tried in civil courts of law.

(4) Certificate of good health from Medical Officer of the Administration. This certificate must also state that the candidate has been re-vaccinated within less than six years from date of application.

(5) Document proving that the candidate has fulfilled his military obligations.

The candidates not already serving in the Postal Administration, who are admitted to the École Professionelle, are drawn from the students of the École Polythenique who have completed the two years' course at the latter Institution; they are not required to pass the examination for admission to the École Professionelle already referred to, which only applies to officers serving in the Postal Administration.

It may be of interest to the readers of the JOURNAL to learn that although the École Polythenique is essentially a military school, and a strict military discipline is maintained there, yet nearly all the civil engineers required for the service of the State are trained at this Institution. Entrance to the École Polythenique is obtained by means of a competitive examination open to young men between seventeen and twenty-one years of age, and as this Institution holds a high reputation owing to the large number of eminent and illustrious Frenchmen who have been trained there, a large number of candidates of high attainments are attracted. Candidates for admission must possess a University-leaving certificate, and success at the entrance examination proves that the candidate has already obtained a wide range of scientific knowledge. At this examination mathematical subjects occupy a very important place, and considerable proficiency is also required in physics, chemistry, and drawing. The aim of the school is to provide a very advanced scientific education. The subjects studied are differential and integral calculus, geometry, mechanics, thermo-dynamics, electricity, optics, acoustics, and chemistry. The students after leaving the École Polythenique receive specialised teaching in a number of schools of practical engineering, such as the School of Mines, the School of Roads and Bridges, etc.

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All the candidates admitted to the École Professionelle Supérieure des Postes et des Télégraphes are appointed "engineer-students," and receive a salary of £72 per annum, and the allowances provided for by regulations. The officers of the Department who are admitted to the School retain the salary of the rank they hold, and they also retain, whilst at the École Professionelle, any rights regarding promotion which they may possess on their class. These officers are also granted an allowance to cover their transfer to Paris, the maximum of which is fixed at £16.

The "engineer-students" have to undergo the instruction laid down for the "Second Section" of the École Professionelle. The course consists of:

(*a*) The theoretical and practical courses in the École Supérieure d'Électricité.

Comprising: General electro-technics; lectures on the application of electricity for traction purposes, etc.; continuous and alternating current generators; construction of electrical machinery; distributing systems, aërial and subterranean; accumulators; electro-chemistry; practical laboratory work, including testing of machines; workshop practice; visits to electric works; preparation of scheme of electric lighting and power transmission; design of plant; calculations in connection with the design of continuous and alternating current generators.

(*b*) The courses and lectures special to the "Second Section."

Comprising: Application of statutory provisions incorporated in the laws affecting the P. O. services; theory of electricity, and its applications to telegraphy and telephony; propagation of electric current in conductors, during its variable period, in relation to telegraphy and telephony; steam, heat and hydraulic machines; automobiles and railways; submarine cables; pneumatic tubes; construction of aërial and subterranean lines; course of architecture; strength of materials; postal materials; laws relating to workmen; machine designs.

(*c*) The courses common to the two sections of the School.

Comprising: General principles of telegraphy and telephony; construction of aërial and underground lines; statutory powers; general principles relating to administration and accounting.

(*d*) Practical studies and visits to places in France and abroad for purposes of instruction.

Comprising: Manipulation on telegraph circuits; testing; English and German conversation and translation; visits to large telegraph and telephone offices; graphic representations; visits to district headquarters in France for study of industrial undertakings; visits to foreign countries for study of a postal, telegraphic or telephonic installation, and of an industrial undertaking; working out of a complete scheme of installation; laboratory exercises.

Further details concerning the subjects mentioned above are given in Appendix II.

During the first year the application of electricity to industrial purposes is studied at the École Supérieure d'Électricité. During the second year the students attend the professional courses of instruction at the École Supérieure

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des Postes et des Télégraphes. Some of the subjects require a considerable knowledge of the higher branches of mathematics, and the necessary instruction is provided for those students who are able to derive profit from the same. A great part of the course in the second year is thoroughly practical in character: the students work out practical problems, signal messages, carry out electrical tests of apparatus and lines, visit important telegraph and telephone offices, go through a laboratory course and prepare projects for telegraph and telephone installations, etc.

The students have to furnish reports in connection with each of their visits relating to the courses of instruction, and their papers carry marks which are added to those obtained at the examinations, the grand totals thus obtained determining the final classification of the students on completion of the course at the École Professionelle.

At the end of the first year an examination is held. It consists partly of written replies to papers, partly of answers to oral questions, and partly of practical tests. The marks obtained at this examination are carried forward to determine the final classification of the students.

At the end of the second year the students have to furnish a scheme relating to a telegraphic or telephonic installation, and also a paper on laboratory work (standardisation, special study of a particular apparatus, etc.). The marks obtained again count for the final classification. In addition, a second series of examinations on the subjects on which instruction has been given, are held. These are also partly in the nature of written replies to papers, partly oral, and partly practical.

For a pass, students must obtain 65 per cent. of marks. Students drawn from the Postal Administration failing to satisfy the Examiners are relegated to the positions they held when nominated for admission to the School, whilst those who were not formerly in the service of the Postal Administration are appointed to clerkships, and retain the scale of pay they may be receiving at the School.

Students who fail at an examination may be allowed to present themselves for re-examination once only. The successful students are appointed 2nd Class Engineers.

It is quite clear from the above account that not only do the French telegraph engineers enjoy the advantage of receiving a thoroughly practical and wide training to fit them for their responsibilities, but that care is also taken that only those shall participate in the course of instruction in the École Professionelle who have shown that they possess the energy to study and are likely to derive profit from the course of studies laid down for the "engineer-students."

It is further recognised that it is not possible for every young man in the P. O. Service to acquire, without assistance, the necessary knowledge to take advantage of the education provided at the École Professionelle, and in consequence, facilities are granted to officials desirous of competing for admission to the "Second Section" of the École Professionelle, for study at one of the higher State Schools at Paris, and, in some cases, at the University.

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I hope at some future date to be in a position to describe the systems adopted by other foreign administrations for training telegraph engineers.

APPENDIX I.

Examination for admission to École Professionelle (Extracts from the programme of the École Professionelle Supérieure des Postes et des Télégraphes).

I. Mathematics.

Differential calculus.—Formation of differential equations; functions of an imaginary variable; Taylor's theorem and extension of same; Demoivre's and Euler's theorems; maxima and minima; indeterminate forms; envelopes and surfaces; plane curves; skew surfaces.

Integral calculus.—Indefinite integrals; definite integrals; lengths of curves; areas and volumes by integration; change of the variable; Green's theorem; successive integration; linear differential equations; systems of simultaneous differential equations; integration of some of the well-known equations of the second order.

II. Mechanics.

Kinematics.—Motion of a point; parallelogram of velocities; motions of a solid; theory of relative motion; cylindrical and conical gears; worm wheels; winch; Stephenson's link motion; Watt's parallelogram.

Statics and dynamics.—Fundamental principles; theory of moments; equilibrium and movements of points under various conditions; gravity; Newton's law of attraction; Foucault's pendulum; equilibrium of forces; funicular systems; equilibrium of fluids; laws of dynamics; theory of moments of inertia; energy; theory of small displacements; d'Alembert's principle; compound pendulum; Pouisot principle; Bernouilli's theorem; Prony brake; fly-wheels; governors; principal parts of steam engine; indicator diagram.

III. Physics.

Heat.—Expansion of liquid and solid bodies; thermometers; compressibility of gases; liquefaction of gases; influence of temperature and pressure on gases; specific heat of gaseous bodies; conductibility; Senarmont's experiments; thermo-dynamics; mechanical equivalent of heat; isothermic and adiabatic curves; Carnot's cycle and principle; absolute temperature; application to perfect gases and saturated vapours.

Acoustics.—Vibratory motion; amplitude; period; phase; measurement of number of vibrations; registering apparatus; musical scale; propagation of sound; velocity of sound in gases, solids and liquids; wave-length; vibration of strings, pipes, rods and plates; compounding of vibratory motions; interference; harmonics; experimental analysis of a sound; phonograph.

Optics.—Study of heat, light and chemical radiations; spectrum analysis; phosphorescence and fluorescence; photography; velocity of light; corpuscular and undulatory theories; periodicity of luminous vibrations; interference; Newton's rings; Huyghen's and Fresnel's principles; diffraction; polarisers and analysers; rectilinear, circular and elliptic polarisation; rotatory and magnetic polarisation.

Magnetism and electricity.—Elementary principles; Coulomb's law; Faraday's experiments; conducting bodies and dielectrics; condensers; electric energy; machines utilising property of induction; electric currents; Faraday's laws; accumulators; Joule's law; Oersted's experiments; Laplace's law; Kirchoff's theorem; Solenoids; electro-magnets; Lenz's law; Foucault's experiments; vacuum tubes; units.

Chemistry.—Metalloids; general laws of chemistry. Metals—generalities and classification; alloys; salts and their properties; laws of Richter and Berthelot; general principles of thermo-chemistry; alkalies; clays, porcelain and glass; extraction,

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properties and compounds of potassium, barium, strontium, calcium, magnesium, aluminium, iron, nickel and cobalt, manganese, zinc, tin, antimony, lead, copper, mercury, silver, gold and platinum.

Organic chemistry—composition of organic bodies; analysis; classification of organic substances; alcohol, ether; aldehyde; organic acids; albuminoids; fermentation.

V. Foreign Languages.

German or French; any other language taught at the Universities.

VI. Drawing.

Geometric drawing; perspective; mechanical drawing.

APPENDIX II.

Extracts from the programme of instruction for the "Second Section" of the École Professionelle Supérieure des Postes et des Télégraphes.

First Year.

Statutory Provisions.

Control exercised by P. O. Engineers; *rôle* of the Electricity Committee; technical instructions relating to industrial electricity undertakings; interpretation of technical instructions; protective regulations relating to high and low tension transmission, and electric tramways; telephone net-works; provision of lines in the neighbourhood of industrial systems; administrative regulations.

Manipulation.

Plan Drawing.

Second Year (First Half-year).

Theoretical Electricity.

General study of the magnetic field in the varying state; fundamental ideas; laws of action at a distance; electric force on unit surface, and unit volume; dissipation of energy in conductors; study of magnetic field; laws of Laplace and Ampère; magnetic energy; study of electro-magnetic field in varying state; laws of induction; equation of electro-magnetic field in a medium at rest; application of same to Hertz's experiments; measurement of velocity of propagation; electro-magnetic theory of light.

Experimental study of dielectrics; polarisation of dielectrics: pyro-electricity; piezo-electricity; action of electric field on propagation of light in electric media; general ideas on apparent conductivity of dielectrics.

Study of conductors.— Study of net-works of linear conductors in cases of constant or varying currents; apparent resistance of conductors carrying alternating currents; variation of conductivity in relation to changes in physical condition.

Magnetic properties of bodies.—Classification of bodies; magnetic permeability and its measurement; magnetisation curves; conditions modifying magnetisation; dissipation of magnetic energy; effect of magnetic field on propagation of light.

Electro-chemistry.—Study of electrolysis; thermo-electricity; electro-capillary phenomena; ultra-violet light; actino-electric phenomena; cathode rays; Röntgen rays radio-active substances; electrification of gases; electric phenomena in rarefied gases.

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(Second Half-year.)

Postal Material.

Manufacture of postage stamps; letter-boxes; indicators, etc.; stamps; obliterating machines; inks; bags; paper; wax; seals, etc.; mail-vans; general study of questions relating to picking up and dropping mails from express trains; postmen's bags.

Construction of Aërial and Underground Lines.

Instruction under this head practically covers matters dealt with in British Post Office Technical Instructions XIII and XIV.

Supplemental Instruction in Connection with Aërial Lines, Submarine Cables, Pneumatic Tubes.

A. *Aërial lines.*—The Catenary; numerical tables; curves and their application; influence of variations of temperature, wind force, and accidental loads on aerial lines; curves relating to same.

B. *Submarine cables.*—Make up of submarine cable and its electrical characteristics; Thomson's law; study of transmission and reception of signals in case of a long perfectly insulated cable; curves at receiving end of conductors, with and without condensers; comparisons between these methods of working circuits; case of a circuit with uniform leakage along its whole length; circuit with single leak: influence of line losses on form of signals; influence of apparatus on ends of line; duplex working; problem of telephonic communication by means of cables; application of Fourier's law of diffusion to various phenomena connected with apparent diffusion of electricity in cables; determination of economic size of conductors in submarine cables and numerical tables relating to same; determination of strength of armouring of cable in relation to conditions to be met; manufacture of armoured cable; cable ships and special materials for work on the sea; laying of submarine cable; theories of Thomson and Siemens; localisation of faults; repairs; lives of cables in various localities; frequency of interruptions, their causes and cost of repairs; Cable Companies.

C. *Pneumatic tubes.*—Pneumatic tube networks; construction; description of apparatus; cost of providing; maintenance; tracing defects; proposed improvements.

Powers of Various Administrative Bodies.

General principles; *rôle* of the State; public and moral power; separation of legislative and executive power; separation of administrative and judicial authority; administrative machinery; the central, county, and local administrations and decentralisation; the central administration, the head of the State, the Cabinet, etc.; details of county administration and officials concerned; municipal administration and officials concerned; external relations and national defence; police; administration of justice; highway authorities; public works and rights of private property invaded to facilitate execution of same; expropriation; optional services undertaken by State, industrial in character, *e.g.* mines, transport, posts, telegraphs, and telephones; services, intellectual in character, *e.g.* education, public worship; public finances, national debt, taxes; bird's eye view of fiscal system.

General Principles of Administration and Accounting.

A. *Rôle of the services.*—General organisation of administration; duties devolving on administration; transmission of postal, telegraphic and telephonic correspondence; accessory services; money orders, cash on delivery, savings bank, parcel post, etc. central administration; supervision; technical committees.

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B. *Fundamental legislation.*—Monopoly—Study of actual situation and comparison between this and situation involving free trade in conveyance of postal matter; postal monopoly and contraventions; telegraph and telephone monoply and contraventions; control of telegrams; railway lines and private interests; secret correspondence and exceptions; responsibility of administration and its officers; exemptions.

C. *Ways and means.*—Budget, definition, preparation, etc.; expenditure, payment, etc.; receipts; different classes of offices; supply of funds to same; different classes of officials; recruitment and general rules relating to promotion; distribution in offices, salaries, etc.

Steam Engines: Heat Engines; Automobiles.

Production of steam.—Combustion of solids, liquids, and gases; calorimetry and practical applications; proportion and arrangement of fire-box; flues and chimneys, and determination of their dimensions; conduction of heat; feed-water heaters; super-heaters; boilers; general rules concerning dimensions of various parts; multi-tubular boilers, Belleville, Niclausse, Babcock and Wilcox; accessories and safety appliances; quality of boiler-plates, tubes, etc.; essentials of good design; administrative regulations relating to installations.

Theory of the steam engine.—General principles of thermo-dynamics; Carnot's cycle; different forms of heat engines, steam engines, gas engines; properties of steam; losses, means to be adopted to reduce same; calculations for determination of dimension of plant for given horse-power; indicators.

Construction of steam engines.—Reciprocating engines; turbines; cylinders, pistons, etc.; valves and valve gears; Zeuner's and other valve diagrams; Corliss and Sulzer gears; advantages of multi-cylinder engines; Woulf's compound engine; calculations relating to engines to develop given horse-power; reduction of losses; governors; feed-pumps; condensers; air-pumps; injectors.

Application of steam engine to compression of air.—Pneumatic pumps; project for installation of pneumatic plant.

Gas engines.—Principles of action; complete study of an Otto type of engine; different systems of ignition and regulation: utilisation of mineral substances, petrol, alcohol, and poor gases.

Automobiles.—Arrangement of chassis; driving mechanism and variable speed gear; steering gear; brakes; examination and comparison of various types of machine.

General Principles of Telegraphic and Telephonic Communication.

Object and division of course. Apparatus required for elementary form of electric communication.

Sources of energy.—Chemical and electro-dynamic generators of continuous current; alternators; telephone; production of Hertzian waves; transformers for converting continuous into alternating current.

Transmitters.—Study of the method of producing signals; keys for uni-directional currents; synchronism; mechanical and electrical governors; correction; double-current keys: automatic transmission; perforators; study of the voice; microphone; Hertzian wave transmitters.

Receivers. — General ideas on electro-magnets; electro-magnets for alternating currents; utilisation of electro-magnets for receiving continuous currents.

Telephone receivers and theory of same; Hertzian wave receivers; syntonisation; relays; Morse, Hughes, Wheatstone, and Baudot apparatus; syphon recorder; formation of signals; time-constants; interference due to induction; protective devices; telephone installations of various magnitudes; telegraph installations.

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ARCHITECTURE AND STRENGTH OF MATERIALS.

Materials of construction; whence obtained, composition, quality, defects, and uses.—Construction: study of site; excavations and foundations; walls; arches and floors; staircases; doors and windows; wood and iron framing.

Roofing; drainage of water; pipe-work; lightning protection; sanitary arrangements; lavatory accommodation.

Joinery; painting; warming and ventilation.

Properties of building materials.

Building of offices; all matters relating to conditions to be fulfilled; observance of building bye-laws; conditions attaching to leases, etc.

EXECUTION AND CONTROL OF THE SERVICE.

Transmission of postal correspondence—conveyance by road, rail and water; distribution; parcel post; transmission of telegraphic correspondence, circulation; general organisation of net-work; distribution and transmission of telephonic correspondence. Rates for services; general organisation of net-work.

Money-order and cash-on-delivery systems.—General ideas on subject; postal orders; telegraphic remittances, etc.

Social and economic value of savings bank; savings bank transactions, etc.

Control of expenditure; general organisation to effect same; accounting and general rules relating to same, etc.

International relations.—Relations with foreign countries—Postal union; exchange of correspondence with foreign countries; international accounts, etc.

Principle of telegraph and telephone conventions with foreign countries and agreements with cable companies; clearing-house arrangements relating to fees received, etc.

LECTURES ON LEGISLATION RELATING TO WORKMEN ACTS.

LECTURES ON THE GENERAL SUBJECTS OF INSTRUCTION.

LECTURES ON ELECTRIFICATION OF RAILWAYS.

LECTURES ON HYDRAULICS.

LECTURES ON SPECIAL SUBJECTS OF TECHNICAL NATURE.

PROFESSIONAL PAPERS.

THE attention of readers is called to the announcement on page ii of our cover as to the supply of copies of the Professional Papers which have been read before meetings of the Institution. In each case the latest available information on the given subject is presented, and the illustrations are clear and arranged for easy reference.

The variation in price is due to the fact that the Council—animated solely by the desire to propagate knowledge—regulates the price by the *cost of printing*. The intrinsic value of the papers is many times greater.

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THE MOTOR-DRIVEN WHEATSTONE TRANSMITTER.

By C. C. VYLE and E. V. SMART.

WHEATSTONE'S automatic system is the best system in the world where the economy of line wire is concerned. Four hundred words a minute can be passed over the wire as against about one hundred by the next best system. This means that three wires at least between the two stations are saved. When great pressure exists on a circuit Wheatstone working is resorted to. When a special event of any importance takes place it is the Wheatstone system that is used to dispose of the work. It is the Wheatstone system that transfers the news of the world from London to all parts of the United Kingdom. When a general breakdown occurs it is by means of the Wheatstone system that the work is disposed of over the few wires remaining. The Wheatstone system is to any key-worked system what our fastest express trains are to the old stage coaches. The staffs at both ends, one lot punching and feeding the transmitter, the other receiving the news and writing it up, soon dispose of the work. One drawback is the writing up of the slip, especially by artificial light; the constant transfer of the eyes from the moving slip to the writing, and *vice-versâ*, is a strain. This might be remedied by producing a slip, which, by being passed through another instrument, could be read by sound.

When required for re-transmission purposes the slip might be gummed on a form. It would be as easy to send from the slip so gummed as from the written words. Much time might be saved by adopting the latter method.

Again, instead of the present form of Wheatstone perforator a key-board perforator would greatly increase the speed of punching.

Enough has been said to show the great utility and supremacy of the Wheatstone system in circumstances when speedy transmission over the line wire is of the utmost importance.

Although many years have elapsed since Sir Charles Wheatstone introduced his automatic system, very little has been done to improve the transmitter, and it remains to-day practically as it was when first invented.

The driving of the transmitter is a matter which has received a great deal of attention with a view to abolishing the use of the heavy weights at present used, and it is in connection with this subject that the present article deals.

It is now more than twenty years since the need for a motor-driven transmitter was first felt. When it was necessary to obtain

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high speeds, the practice was, and still is, to tie extra weights to the driving weight; this frequently ended in disaster and the suspension of work until a fresh transmitter had been obtained.

The difficulty in obtaining high speeds was the prime cause of a motor-driven transmitter being sought, but many other reasons can be advanced for the demand. Some of these are:

(1) To obviate the need for weights (45 lb. each) and weight guards.

(2) To avoid transmitters "running down" during the transmission of messages, and the consequent confusion, loss of time, and repetition of work.

(3) To relieve the telegraphist of the labour of frequent winding, leaving him free to attend to slips, etc.

(4) To minimise the liability to shocks. Shocks have occasionally been experienced by telegraphists while winding transmitters. In this connection it may be mentioned that an extra terminal was recently provided on the transmitter for the purpose of connecting the frame work of the transmitter to earth.

(5) To ensure constant speed of the transmitter when used in connection with apparatus where "slowing down" or "racing," due to overwinding, results in malformation of the signals, rendering the slip unsuitable for re-transmission or printing purposes.

(6) To prevent the cutting of instrument tables to provide for the movement of the chain attached to the weight.

When the need was first felt, an electrically-driven transmitter was designed, but this, in common with others since designed, did not give constant speed, and on this account the signals were unreliable. Other electrically-driven transmitters have been unsuitable, because, in arranging for varying the speeds of the motor by shunting some of the current, considerable overheating took place; they, too, were subject to the troubles of momentary racing and irregular running.

Air-driven transmitters were also tried, but were unreliable, on account of the difficulty in maintaining constant pressure. The air actuated a fan that was attached to the driving axle.

The Hughes instrument is one to which motor-driving has been successfully applied, but in this case the instrument is driven at a constant speed and the work done is kept constant by means of a governor.

The requirements for a motor-driven Wheatstone transmitter are:

(1) It shall be capable of running at any speed required for Wheatstone circuits.

(2) It shall give constant speed when run at any given rate.

(3) The motor and controlling apparatus shall not overheat.

(4) The speed must be easily controlled.

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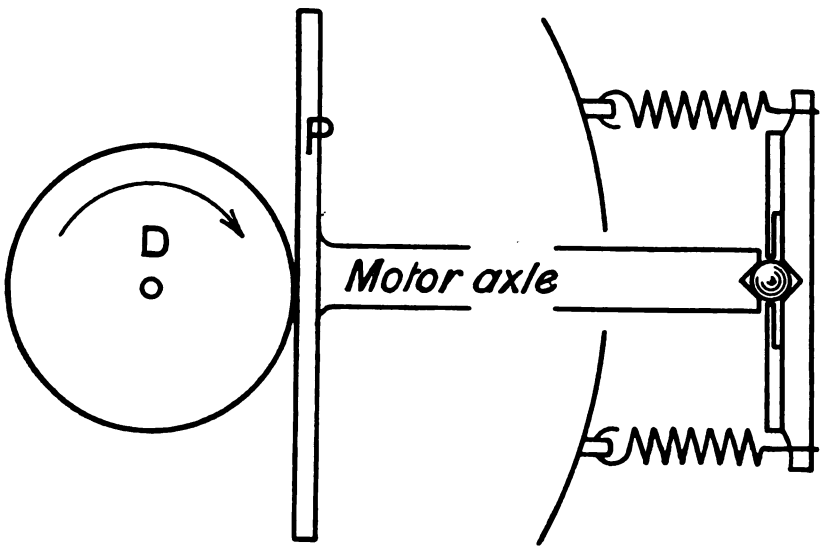
Small motors with electrical governing, such as are required for Wheatstone transmitters, are not easy to design when all the requirements mentioned have to be met, and all attempts hitherto have failed. Mechanical means have been attempted, but have not, until the present instrument was designed, proved satisfactory.

Small motors to be efficient should have their armatures to revolve at constant high speeds. If the efficient speed of the motor be too high for the purpose required, it should be reduced by *gearing*. This is the fundamental principle of the motor-driven transmitter designed by the writers.

Choose a motor of sufficient horse-power to do the work easily



I.—MOTOR-DRIVEN TRANSMITTER.

and keep its speed invariable and high. With this explanation the description of the instrument should be easily followed:

A motor, 110 v. $\frac{1}{16}$ h.p. (series wound, for a reason to be explained later) has a thick German-silver plate fitted at one end of the axle; this, backed up and made rigid, is used as a friction-plate. On the front of the friction-plate rests the edge of a friction-disc, consisting of two thicknesses of compressed hide held tightly between two metal plates. The metal plates are slightly less in size than the hide discs, to prevent the metal touching the friction-plate.

The contrivance sketched in Fig. 1 shows how the friction-plate and disc are kept in firm contact. A ball is held to the end of the armature axle remote from the friction-plate. A short piece of steel, each end of which is connected to the shell of the motor by a spiral spring, presses on the axle by way of the ball bearing. The friction-

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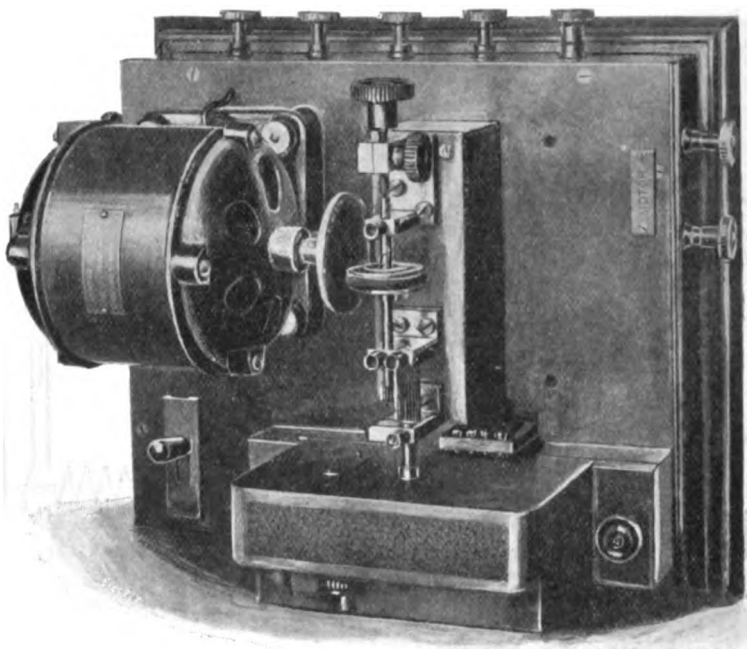
plate might be kept to its work by the motor being so placed that the armature, in striving to get to its normal position when running, keeps the friction-plate forced towards the disc. (When a motor is running, the armature, if free to do so, places itself in a certain definite position, and considerable force is necessary to move it from that position. If, now, the motor be so set, with respect to the friction-disc, that the friction-plate just touches the disc and the armature is to the left of the position referred to, the force tending to bring the armature to the right will keep the friction-plate up to its work.)

The friction-disc is fitted on an axle, at one end of which is a



2.—Motor-driven Transmitter.

pinion gear to which the driving axle of the transmitter is connected by means of a clutch; at the other end is a cup-like end into which fits a pointed termination of the adjusting screw, this latter being in alignment with the friction-disc axle. The general arrangement will be seen from the photograph (Fig. 2), in which the observer is looking down on the instrument.

The method of varying the speed is on the well-known principle that the various parts of a revolving wheel have different speeds through space; *e.g.* any part of the periphery of a wheel travels much faster than a part near the centre. The adjusting screw pushing the friction-disc axle inwards, causes the friction-disc to be carried

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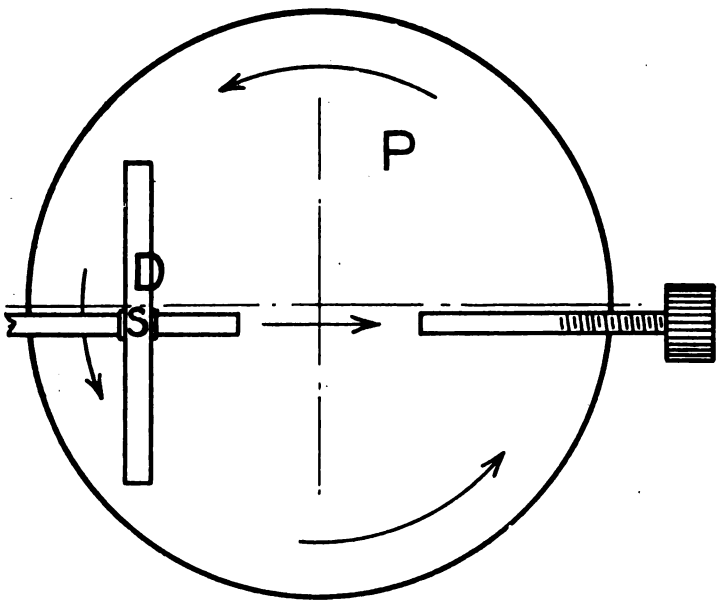
from the centre to the periphery of the friction-plate, varying the speed *from slow to fast* in so doing. To vary *from fast to slow*, another property of a revolving wheel has been utilised. The upper half of a revolving wheel has a motion contrary to that of the lower half, and anything rubbing against the side of a revolving wheel, if free to do so, takes up the motion of translation of that part of the wheel on which it rubs. Assume the friction-disc to be placed in the left lower half of the friction-plate near the periphery. On causing the friction-plate to revolve in a non-clockwise direction, the friction-disc will travel towards the centre. A sketch will make matters clear (Fig. 3).

The friction-plate P is revolving in a non-clockwise direction, the



3.—MOTOR-DRIVEN TRANSMITTER.

friction-disc D is placed at position S, this being to the left of the vertical diameter and below the horizontal diameter of P. By virtue of D's position to the left of the vertical diameter, there is a tendency for it to take a downward motion, but, as it is not free to move bodily downwards, and, as the part touching the plate is the periphery of a wheel, that sustained downward force on every part successively produces a circular motion of D. By virtue of D's position below the horizontal diameter it has a tendency to move to the right. If the adjusting screw is not pressing against the friction-disc axle, the disc will move to the right. From these considerations it will be seen that it is only necessary to take the adjusting screw outwards for a reduction of speed; the force on the disc, due to its position below the horizontal diameter of the plate, causing the disc-axle to follow

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in the same direction. Screwing inwards to increase speed is against that force.

All speed variations for the transmitter are thus brought about without interfering with the speed of the motor.

When an ordinary transmitter is started on a quadruplex circuit, we find, owing to the comparatively slow arrival at its proper speed and the line being disconnected for comparatively long periods during the time taken, that the signals on the B-side are interfered with. With a series-wound motor-driven transmitter, the speed desired is obtained almost instantaneously on account of its great starting powers. The work for the motor-driven transmitter is practically constant, so that variation in speed due to variable work has not to be allowed for; the friction introduced by the paper is negligible on account of the friction already present.

A dust-proof switch is used to start the instrument. This switch operating a bell crank lever connects the power leads to the motor, the batteries to the transmitter contacts, and also makes the connections through the transmitter as in weight-driven instruments.

The clockwork or front portion of the transmitter is attached to the driving portion by means of a clutch so shaped that the need for a given position to grip is obviated: it fits in any position. The connections are provided by means of buffer contacts. When the front portion is pushed into position, the contacts are securely made and a raised edge keeps the front pressed back. It is clamped by two plates and thumb-screws. The clock-work or train has been reduced to a minimum, the frame containing this portion being about one half the size of that used for weight-driven transmitters. A change of transmitter can now be made very quickly. It has been demonstrated that the change can be made in ten seconds.

The instrument which has been described cannot be said to be a *new* instrument. A great deal of the valuable part of the weight-driven transmitter has simply been transferred to the motor-driven instrument. The instrument has been used recently in connection with some trials of the Wheatstone system between Edinburgh and London and has proved a boon to the telegraphists, who speak highly of the relief afforded them.

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THE DESIGN OF TELEPHONE AND TELEGRAPH CABLES.

By A. G. LEE, B.Sc.

THE fundamental point in the design of cables for telephone or telegraph work is the combining together of a number of pairs or wires of the required efficiency in a symmetrical manner.

Before commencing the design of a cable the following particulars should be known:

(1) The number of pairs or wires required.

(2) The efficiency required in terms of 20 lb. standard cable (or, in the case of telegraph circuits, the K.R. per mile). This is determined by the length and type of transmission required, and the rules for finding it are well known.

It will be seen below that the efficiency may be obtained in two different ways:

(*a*) By large gauge conductors.

(*b*) By smaller gauge conductors and increasing the size of the cable to give low capacity.

The mere provision of a certain gauge of conductor does not necessarily mean that the efficiency required will be obtained if the pairs are tightly packed into the cable in order to obtain a large number of circuits.

The rules for finding the number of wires that will go into a cable will first be given, and afterwards a few examples worked out.

SIZE AND NUMBER OF WIRES IN A CABLE.

The diameter of any cable, D, with n round wires in the outside layer, each of diameter d, is:

$$D = d \times \left(1 + \operatorname{cosec.} \frac{180^\circ}{n}\right)$$

From this formula the number of wires that will go into a layer may be found when the diameters d and D are known.

The following values obtained from the formula are very useful, and should be committed to memory.

When $n = 3$ $D = 2{\cdot}155\ d$
,, $n = 4$ $D = 2{\cdot}414\ d$
,, $n = 5$ $D = 2{\cdot}7\ d$
,, $n = 6$ $D = 3\ d$

In paper cables, however, a pair of wires is not perfectly circular in section, and adjacent pairs fit into one another to a certain extent, so that a larger number of pairs can be placed in a layer than

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is indicated by the above formula. On the other hand, no allowance is made for the section of the wires, in an orthogonal section of the cable, being elliptical, due to the wires passing in a spiral round the cable.

Taking into account these two considerations, the following simpler formula will be found to meet the case of paper cables more nearly.

The number of pairs that will go into a layer is—

$$n = \frac{(D-d) \times 3}{d}$$

where D−d is the pitch circle diameter and d=diameter of wire or pair.

It should be explained that the pitch circle diameter is the diameter of the circle passing through the centres of all the pairs in the layer.

Telephone Cables.

The following table, No. 1, shows how the ordinary twin cables, with all the conductors of the same gauge, are made up.

It will be observed that the simpler formula given, which has been used in compiling this table, causes the number of pairs in succeeding layers to increase by 6. Where the number of pairs in a layer is large a few extra pairs may be put in. For instance, in the 1600 wire cable, the pairs in the layers increase by 7 towards the outside of the cable.

The diameter of any of these cables is the sum of the diameter of the centre core, plus the diameter of a pair multiplied by twice the number of layers.

Example.—To find the diameter of a 1200 wire cable.

There are 12 layers and the diameter of the centre core of 3 pairs is 2·15 d.

Then diameter of cable

$$\text{is } 2{\cdot}15\,d + 24\,d$$
$$= 26{\cdot}15\,d$$

where d=diameter of pair.

To find the external diameter of the cable two thicknesses of lead sheathing should be added to the figure previously found.

Relation of Diameter of Pair to Efficiency.

It is found that considerable variation in the wire-to-wire capacity occurs between cables made at different times and by different manufacturers.

When the average of the results obtained over a period is long worked out, it is found that the wire-to-wire capacity per mile in

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TABLE No. 1.—*Order of Stranding.*

Number of Conductors in Cable.	Number of *Pairs* of Wires in Central and succeeding Layers.														
	Centre.	1st.	2nd.	3rd.	4th.	5th.	6th.	7th.	8th.	9th.	10th.	11th.	12th.	13th.	14th.	15th.
6	3															
8	4															
14	1	6														
24	3	9														
30	4	11														
38	1	6	12													
50	3	8	14													
52	3	9	14													
54	3	9	15													
74	1	6	12	18												
96	3	9	15	21												
100	3	9	16	22												
104	4	10	16	22												
122	1	6	12	18	24											
150	3	9	15	21	27											
154	3	9	15	22	28											
182	1	6	12	18	24	30										
200	2	7	13	19	26	33										
204	2	8	14	20	26	32										
216	3	9	15	21	27	33										
254	1	6	12	18	24	30	36									
294	3	9	15	21	27	33	39									
300	3	9	15	21	27	34	41									
306	4	10	16	22	28	34	39									
338	1	6	12	18	24	30	36	42								
358	1	6	12	18	25	32	39	46								
384	3	9	15	21	27	33	39	45								
400	4	10	16	22	28	34	40	46								
408	4	10	16	22	28	34	41	49								
434	1	6	12	18	24	30	36	42	48							
486	3	9	15	21	27	33	39	45	51							
500	3	9	15	21	27	34	40	47	54							
510	4	10	16	22	28	34	40	47	54							
542	1	6	12	18	24	30	36	42	48	54						
600	3	9	15	21	27	33	39	45	51	57						
612	3	9	15	21	28	34	40	46	52	58						
700	1	7	14	20	26	32	38	44	50	56	62					
800	1	6	12	18	24	30	36	42	48	54	61	68				
806	1	6	12	18	24	30	36	42	48	55	62	69				
900	4	10	16	22	28	34	40	46	52	59	66	73				
1000	2	8	14	20	26	32	38	44	50	56	67	70	77			
1100	1	6	12	18	24	30	36	42	48	54	60	66	73	80		
1200	3	9	16	22	28	34	40	46	52	58	64	70	76	82		
1600	4	10	16	22	28	34	40	46	52	58	64	71	78	85	92	100

general varies directly with the gauge of the wire and inversely as the overall diameter of the pair.

The following expression represents an average value so obtained:

$$K\ (\text{mfs}) = 0{\cdot}2 \times \frac{d_1}{d}$$

where d_1 is the diameter of the wire, and d is the diameter of the pair, and is fairly true for 20 lb. and larger conductors.

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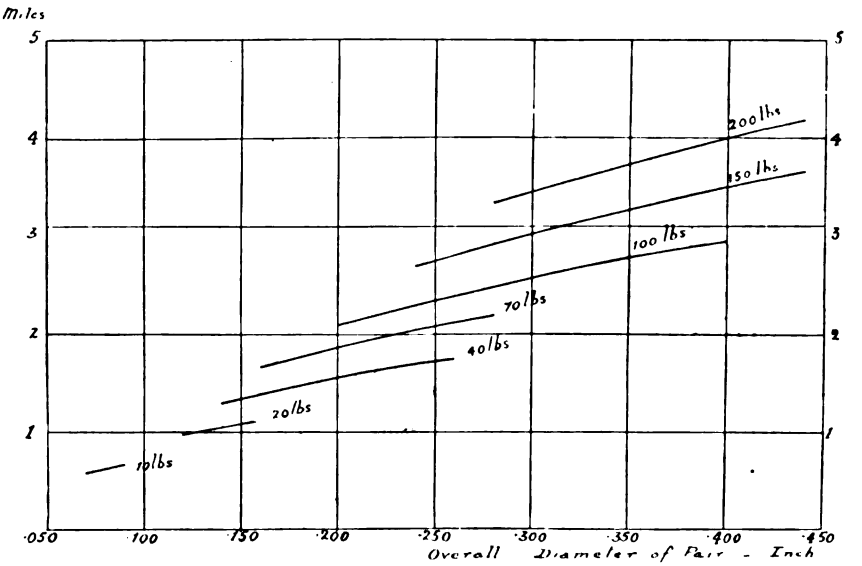
The loop resistance per mile of the wires varies inversely as the square of the diameter, or—

$$R \text{ (ohms)} = \frac{107{,}200}{d_1^2}$$

where d_1 = diameter of wire in mils.

Using these two expressions in Pupin's attenuation formula, the



I.—Variation of efficiency with overall diameter of pair.
Miles of cable equivalent to 1 mile of Zoll's standard cable.

efficiency in terms of the number of miles of cable equivalent in speech transmission to one mile of 20 lb. standard cable is given by—

10 lb.	pair	0·0687	× $\sqrt{d}$	miles
20 lb.	,,	0·087	× $\sqrt{d}$	,,
40 lb.	,,	0·108	× $\sqrt{d}$	,,
70 lb.	,,	0·131	× $\sqrt{d}$	,,
100 lb.	,,	0·148	× $\sqrt{d}$	,,
150 lb.	,,	0·174	× $\sqrt{d}$	,,
200 lb.	,,	0·2	× $\sqrt{d}$	,,

where d is the diameter of the pair in mils.

The change of inductance with the diameter of the pair has been neglected in these calculations, as the wires do not usually occupy central positions in their insulating envelopes, but are pulled close together by the twinning operation.

The possible error due to neglect of the change in this factor is of the order of 5 per cent. on the 200 lb. size and less on the other sizes.

Fig. 1 shows the variation of efficiency with diameter of pair of different gauges of wire.

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Composite Cables.

The straightforward type of cable shown in Table I is usually only required near large exchanges. For trunk and junction working it is necessary to combine pairs of different efficiencies into one cable.

The procedure in this case is as follows:

The number of circuits required and their efficiency should first be ascertained.

Three examples of the design of such cables will be given.

Example 1.—It is required to combine 200 20 lb. wires and 600 10 lb. wires into one cable. Reference to the curves in Fig. 1 will give the diameters of these pairs necessary for the desired efficiency.

Table 1 shows that a 200 wire 20 lb. cable can be made up as follows:

	Centre.	1st layer.	2nd layer.	3rd layer.	4th layer.	5th layer.
Number of pairs	2	7	13	19	26	33

The diameter over this portion of the cable must now be found.

The diameter of two pairs twinned together is 1·4 times the diameter of one pair. The diameter over the 20 lb. cable will therefore be 11·4 d. Taking 140 mils as the diameter of the 20 lb. pair to give the desired efficiency we have —

$$D = 1{\cdot}6 \text{ inches.}$$

A trial calculation, taking the diameter of a 10 lb. pair as 80 mils, gives the number of pairs in the first layer of 10 lb. as 63. As there are 300 pairs required there will be 4 layers with an average of $\frac{300}{4} = 75$ pairs per layer.

This would be the number of pairs in a layer equidistant from the inner and outer layers, therefore the layers on each side of this mean layer, in this case, have 3 pairs more and less respectively, that is, the second and third layers have 72 and 78 pairs respectively. The first layer of 10 lb. will therefore have $72 - 6 = 66$ pairs, and the fourth layer $78 + 6 = 84$ pairs. If there is a layer equidistant from the inner and outer layers (in the case where the number of layers is odd) then the number of pairs in the layers on either side of it differ by 6 from the number in the mean layer.

The arrangement of the cable will therefore be:

	Layers.								
Centre	1st	2nd	3rd	4th	5th	6th	7th	8th	9th
2	7	13	19	26	33	66	72	78	84
	100 20 lb. pairs.					300 10 lb. pairs.			

It is now necessary to calculate the diameter of the 10 lb. pair afresh to see that the necessary efficiency will be obtained.

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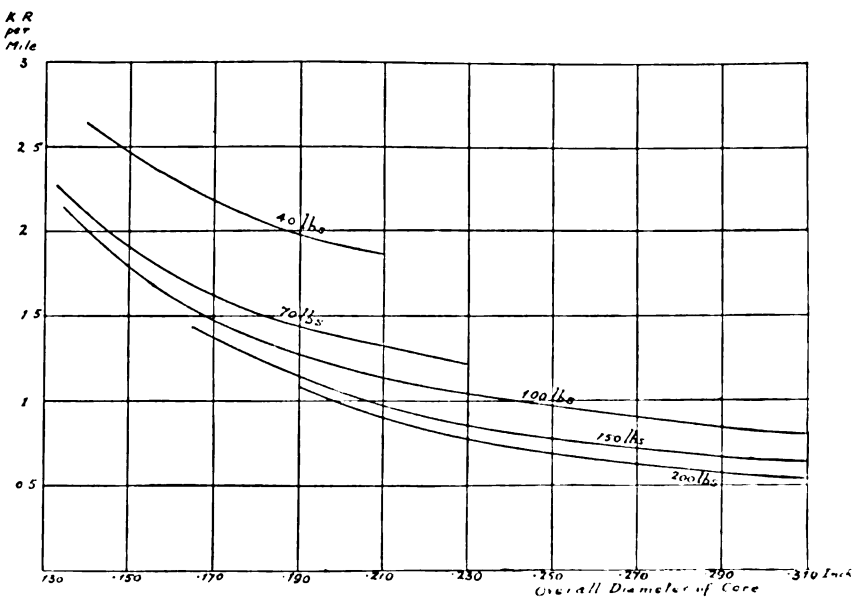
It is $\frac{1{\cdot}6 \times 3}{63} = 76{\cdot}2$ mils.

It will be observed that 1·6″ has been taken instead of the pitch circle diameter (1·6 + d); 1·6″ is a mean between the pitch circles above and below it, so that the number of pairs that will go into it is 3 less than in the layer above. Hence 63 is used as divisor instead of 66.

Example 2.—It is found that the following wires will be necessary to supply a given route with circuits of a certain efficiency: 24/100 lb. wires + 6/150 lb. wires for telephones and 6/70 lb. + 18/200 lb. screened wires for telegraphs.



2.—K.R. per mile of screened cores of different diameters.

As the screened wires have to be in the outer layer of the cable in contact with the lead sheath, their number and size determines the overall diameter of the cable. In this case the calculation may be conveniently commenced at the outside of the cable.

Fig. 2 gives the overall dimensions of screened wires of different efficiencies.

As the number of screened wires is small we will take a large diameter, 315 mils, for the 200 lb. cores, so as to allow plenty of room for the telephone pairs inside the cable.

The diameter under the lead sheath is—

$$D = \frac{18 \times {\cdot}315}{3} + {\cdot}315 = 2{\cdot}205.''$$

This leaves 2·205 − ·630 = 1·575″ for the telephone pairs.

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The 100 lb. pairs may be made up in quad-pair formation, with three cores of four pairs each.

The diameter of the quad core will be—

$$\frac{1{\cdot}575''}{2{\cdot}15} = {\cdot}733''.$$

As each core consists of four pairs, the diameter of each 100 lb. pair will be—

$$\frac{{\cdot}733''}{2{\cdot}4} = {\cdot}305''.$$

The 150 lb. pairs may now be placed as worming between the quad cores, the diameter which may be allowed to them being about 0·48 of the diameter of the quad core,

or 350 mils.

The 6/70 lb. screened wires will now go in on either side of the 150 lb. pairs, the diameter which may be allowed to them being 0·6 of the diameter of the larger worming pair,

or 210 mils.

Reference to the curves will now show whether the efficiences of the various types of wires are in accordance with the requirements.

Fig. 3 shows the diagrammatic arrangement of the cable.

Example 3.—Required about 120 100 lb. wires plus 29 70 lb. screened wires.

In this case we again start the calculations from the outside layer.

Taking ·215″ as the diameter of the 70 lb. screened wires to give the required efficiency, the diameter under the lead sheath is—

$$\frac{29 \times {\cdot}215}{3} + {\cdot}215 = 2{\cdot}3''.$$

This allows 2·3 − ·430 = 1·87″ for the telephone pairs.

In this case we will make up the cable with 4-wire cores of the multiple twin type, a good arrangement being:

Centre.	1st layer.	2nd layer.
4	10	16 = 30 4-wire cores.

The use of 8-wire multiple twin cores is not recommended, owing to the loss of space between the large cores. The same argument applies to the 8-wire quad pair cores, unless the space is filled in with worming pairs.

The diameter of the 4-wire cores will be—

$$\frac{1{\cdot}87''}{4{\cdot}6} = {\cdot}292'',$$

and the diameter of the 100 lb. pairs—

$$\frac{{\cdot}292''}{1{\cdot}4} = 210 \text{ mils.}$$

Reference to Fig. 1 shows that this gives rather a low efficiency, and the diameter of the cable should be increased if possible. If the

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cable is going into a $3\frac{1}{4}''$ pipe the diameter under the lead sheath may be 2·62 inches.

If all the diameters be increased in the ratio $\frac{2{\cdot}62}{2{\cdot}3}$ (where 2·3 was the diameter first found), the same relative dimensions will be obtained.

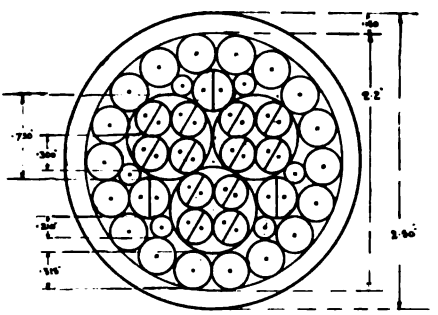
The diameter of the 100 lb. pair will now be—

$$210 \times \frac{2{\cdot}62}{2{\cdot}3} = 240 \text{ mils.}$$

The efficiency is still rather low. If it is not desired to lay a larger pipe or another cable, the efficiency may be improved by putting in 150 lb. or 200 lb. conductors in place of 100 lb.

A few remarks on the efficiency curves in Figs. 1 and 2 may here be of interest.

Fig. 1.—It will be seen that the same efficiency may be obtained



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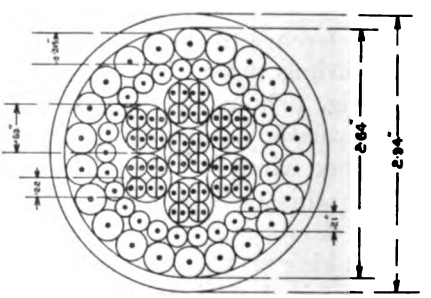

4.

with two adjacent gauges of wires over a short range on each curve. Where the efficiency required comes within this range the smaller gauge wire, in general, makes the cheaper cable.

The more usual problem, however, is that a very large number of circuits are required, and the size of the cable is limited by the size of the pipe. In this case the larger conductors may give the required efficiency without the expense of laying down a second pipe line, and cable.

Fig. 2.—The same remarks apply to a large extent in the case of screened wires. The necessity for having the screened cores against the lead, as already pointed out, usually determines their size. It will be seen that the efficiencies of the different gauges overlap to a large extent so that a wide choice of type is possible.

The difference in cost between, say, a 70 lb. and a 40 lb. screened core of the same efficiency is very small, owing to the cost per lb. of the screening tape being about 40 per cent. higher than that of copper wire, and as the 70 lb. core is smaller for the same

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efficiency, more wires may be put into the cable. The *cost per wire* would in such a case probably work out cheaper with the larger gauge conductor when the cost of the lead sheath is taken into account.

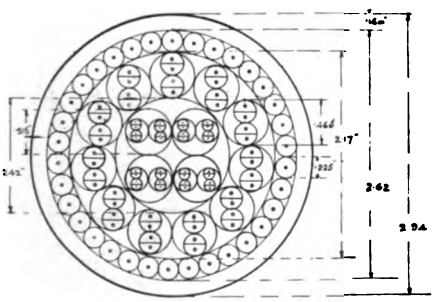
Lead Sheath.

The thickness of lead sheath necessary is determined by several considerations:

(1) A minimum thickness is necessary to prevent blowholes and flaws, and to provide against corrosion, etc.

(2) The lead must be sufficiently strong to withstand the air-pressure test.

(3) The lead may have to take part of the pull of the cable grip if the cable end is not properly prepared.



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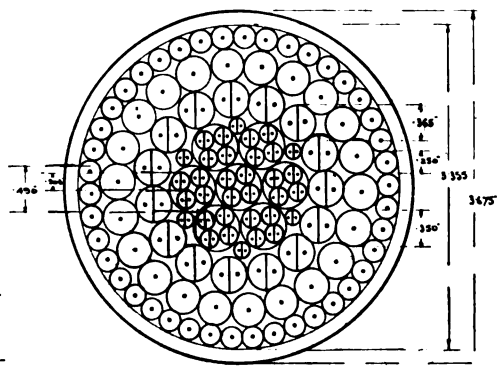

6.

The following formula is fairly in accordance with the thickness found necessary by the Post Office:

Thickness = ·055″ + ·04 d″ where d″ is the diameter of the cable under the lead sheath.

It provides a large factor of safety for cases (2) and (3), but with regards to (1) accidents will sometimes happen against which it is impossible to reasonably provide.

For aërial lead-covered paper cables and exchange cables not subject to the mechanical stresses incidental to pipe work, which tend to open any defects in the lead sheath, much thinner lead may be used.

The following expression is applicable in these cases:

Thickness = ·030″ × ·04 d″.

In all cables we allow the manufacturer 2 per cent. variation above and below the mean external diameter of the cable. Allow-

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ance must be made for this in calculating the size of the cable to go in a given pipe.

The number of possible combinations of conductors in a cable is very large, but there is no space to give them here. Figs. 4, 5, and 6, with those already given, however, illustrate the most usual arrangements of wires in a cable, the majority of other cables being variations of these types.

RECENT CABLING WORKS.

THE following particulars of the work in connection with the Birmingham - Bromsgrove cable speak well for the energy and efficiency of the officers concerned.

Length of route . 13 miles.
Diameter of pipe . 3¼ inches.
Type of cable . . 32/100 Q.P. + 2/100 twin + 4/200 S.S. + 29/70 S.S.
Diameter of cable . 2·75 inches.

	Commenced.	Completed.	No. of working days.
Pipe-laying .	Feb. 12 .	March 23 .	35
Cabling . .	March 5 .	,, 31 .	23
Jointing .	,, 6 .	April 8 .	29

The cable sections were 176 yards in length. The joints were buried.

Extensive works in connection with the main underground telegraph system have recently been carried out in the same speedy manner in the Southern and Scotland (West) Districts.

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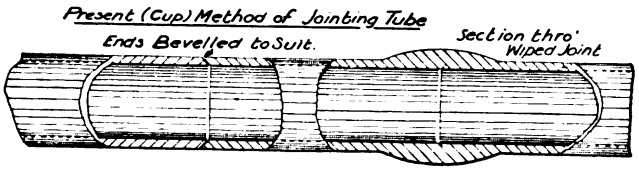
PNEUMATIC TUBE JOINTS.

THE usual method of connecting the lead tube after a fault in a pneumatic tube has been removed has hitherto been by means of a cup joint, as shown in **1**.

In order to make this joint it is necessary to open ground to the first joint in the protective iron pipe, usually a distance of nine feet, to enable the tube to be raised to an angle sufficient to allow the bevelled end of the tube to enter the convex end before being lowered to the horizontal position.

The joint, as shown in **2**, is designed to avoid the necessity of



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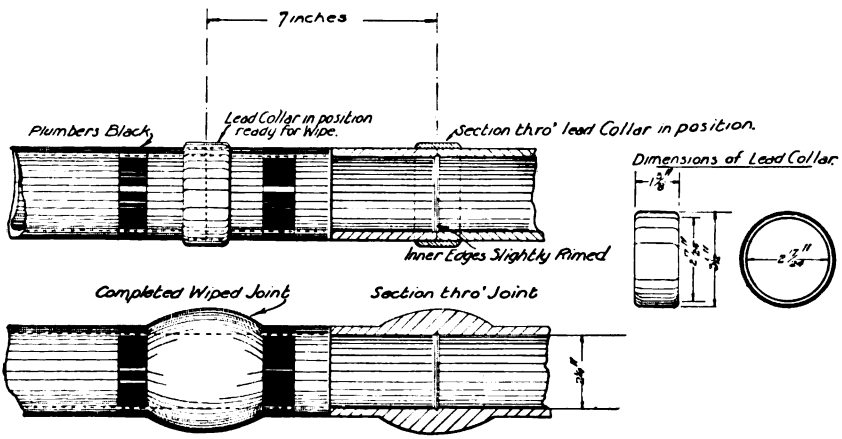

2

opening the extra length of ground. The faulty part of the tube is cut out and a gap of about 7 inches is left, into which a piece of tube is inserted, on which two bevelled lead collars $1\frac{1}{4}$ inches wide fitting tightly on the tube have previously been fitted. The short length of tube is fitted in its position, the collars are brought over the centre of the joints, and the bevelled edges closed around the tube, and ordinary wipe joints are then made over them.

A tool consisting of a circular milling cutter mounted on a mandril has been made to turn the ends of the tube in order to ensure a close joint.

Besides being more economical, the joint is more satisfactory than the cup joint.

The new joint, as well as the design of the necessary tools, is the work of Foreman G. J. Burrett, Central Metropolitan District.

W. N.

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REMINISCENCES OF OVERHEAD AND UNDERGROUND TELEGRAPH WORKS.

By G. W. Hook,
Superintending Engineer, South Midland District.

Before touching on underground matters I would like to record my recollection of the early days of the Post Office Telegraphs, just after the transfer in 1870. I was attached to the London Division under the late Mr. F. Isherwood, who was Divisional Engineer, and to the best of my recollection our work was direct with the Secretary without the intervention of Mr. Culley, who was at that time the Engineer-in-Chief.

The Staff comprised the Divisional Engineer, two senior inspectors, three Inspectors (of whom I was one), and two clerks, supplemented by writers. The London Division was divided into three sections, comprising the N. & N.W., the W. & S.W., and the E. & S.E. I had charge of the N. & N.W., Mr. J. Trott the E. & S.E., and Mr. H. D. Hasdell the W. & S.W. Of the Established Staff, as it was constituted at the time of the transfer, I believe I am the only surviving officer.

Of these early days there is much which, in the light of our present organisation and methods, seems strange. The Divisional Engineer dealt with construction work at first, and personally paid the men. Afterwards the Inspectors took over the construction as well as maintenance.

It was a glorious time for wayleaves. Very little difficulty was experienced in obtaining free consents for the fixing of wires to chimney stacks, or even roof standards, and the public seemed to feel honoured by the asking. Think of it, some of you young sectional engineers. I remember one case in one of the principal streets of North London. There were two adjoining shops belonging to one owner (it was a first class drapery establishment), and the parti-wall was an excellent position for a roof standard. I obtained the owner's consent, and, as I was rather doubtful whether the consenter would like the look of the standard and wires when erected, I had them put up quickly on a Saturday afternoon after the establishment had closed. Some days after, the foreman told me that the proprietor had visited the works, and that he would like to see the gentleman who had obtained his consent for the erection of the telegraph pole on the roof of his premises. I, of course, expected that he had altered his mind and wanted it removed, so I thought I would give him time to cool down. At last I faced it, and called, when, to my relief, he said he wished to say that "he was much

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obliged to me for selecting his premises for the pole as he thought it *made the shop look more imposing.*"

On another occasion I had to construct a very large number of fire-alarm circuits for the old Metropolitan Fire Brigade (now London County Council Brigade) and I applied to headquarters for assistance in connection with wayleaves. An officer was sent to me and I explained to him clearly, as I thought, the particulars of the duty required of him. I took him to a street containing about twenty houses on each side of the road, and told him a consent for a fixing on any house there would suit. Some days elapsed and I asked him how he was getting on in —— Street, and he replied, "Oh I have got all except one, and he won't have it at any price." He thought I had said *every* house instead of *any* house.

In connection with the same work (fire-alarms) I called on a shop-keeper in the East End of London and tried to persuade him to let me fix the wires to his chimney-stack, but when I told him for what purpose they were intended, and that the alarm would be at the corner a few doors up, he absolutely declined. I pointed out the advantage it would be to him to be able to call up the firemen in case his place was on fire; but it was like waving a red flag to a bull, for he said, "When he had a fire, he hoped it would be a good one, and he should not want any firemen to be anywhere near." Way-leave-getting is truly very uncertain.

I think one of the most exciting of my experiences was the following: My section included the maintenance of the wires on the North London Railway, including the signal wires and double-needle instruments in the booking offices. The block instruments in the signal cabins were maintained by a firm of instrument makers. This divided maintenance was very confusing and led to much friction. One day I received an urgent message from the company's officials informing me that the lineman was causing much confusion at Dalston Junction, where he was renewing some wires. I immediately went to Dalston and found that trains signalled on No. 1 were coming in on No. 2, and *vice-versâ*. I saw the danger at once, and the lineman was getting very excited; so I immediately had all the signal wire leads disconnected and asked the railway officials to arrange to "flag" the trains through until the signal wires were put right. I thought it safer to have *no* signals than unreliable ones, and all those who know Dalston Junction Station will appreciate my feeling of relief when I had transferred the responsibility to the railway officials.

Passing on to underground work, the old gutta-percha wire system lent itself conveniently to almost any condition. Each wire being separately insulated could be taken direct either to the instrument or to a test box. Bakers' ovens caused some trouble owing to

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the heat under the paving causing the percha to melt. Other undertakers, such as gas, water, and hydraulic companies' workmen, would sometimes unwittingly cause damage when working by night through hanging naphtha lamps on our pipes in excavated holes. A peculiar case occurred in St. Paul's Churchyard, where a new building was in course of construction. We had two pipes containing gutta-percha wires under the footway in front of this building and these wires became faulty. On localising, the faults were proved to be in the section close to the new building, and on drawing out the cable the percha at one point was seen to have been subjected to heat. The contractors declared that they had had no fire at this spot; but on close examination of the ground I noticed that the paving stone had been removed at a spot behind the hoarding just over our pipes, and that a quantity of lime was lying about. I came to the conclusion that the lime had become wet, and so generated heat above the pipes sufficient to melt the percha. I tried the experiment in our depôt, and the result satisfied the contractors, who ultimately paid the cost of repairs.

While on the subject of gutta-percha wires it may be of interest to relate my experiences in connection with the socialist and unemployed riots of about twenty years ago. Two or three days before the "Black Sunday" riot in Trafalgar Square, my Superintending Engineer called me into his office and told me that the police authorities required certain special circuits, connecting up Old Scotland Yard with stations in the neighbourhood of Trafalgar Square and the station near the Magazine Barracks in Hyde Park.

In order to provide the latter it was necessary to increase the number of gutta-percha wires in a line of pipes across Hyde Park. A cable was laid out at the joint-box about the middle of the park, ready to be pulled into the pipes, when two or three Socialists came on the scene and began to make uncomplimentary remarks about Government men. I told the cable men not to reply but to get on with the work as quickly as possible. Presently, two of the Socialists stood on the railings and waved red flags, when others, in groups of twos and threes, came across the Park and formed a very ugly crowd. Our men could hardly keep from answering back, but as the crowd began to pull the wires about I quietly sent a man over to the magazine station asking for police assistance, and when a few constables appeared coming at the double, the Socialists scattered like rabbits and we were able to complete our work.

The next day, Saturday, I was informed by my superintending engineer (the late Mr. H. Eaton), that a big gathering of Socialists was expected in Hyde Park and Trafalgar Square on the Sunday, and that the police authorities anticipated that an attempt would be made to cut the wires connecting up the stations, by men who had

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worked for our Department. I volunteered to be on duty at Scotland yard with men and appliances ready for any emergency, and found many willing linemen to act with me.

On the Sunday there was a crowd of the most evil-looking ruffians from the east end, filling the streets of Whitehall and the neighbourhood, but Trafalgar Square was closely packed with hundreds of special constables, each armed with a truncheon. During the day we patrolled the routes of the wires but only one fault occurred, and that was on the circuit between Scotland Yard and the National Gallery. I managed to get through the crowd in course of time and found the stoppage was caused by an instrument fault. This was rather an important circuit, as soldiers were stationed here in case they might be required, and I believe they had a plentiful supply of buckshot cartridges in their pouches.

In the archway leading from Whitehall to Old Scotland Yard Police Station the police stood shoulder to shoulder four deep to keep the crowd from raiding the station, and at one time it was so threatening that the iron shutters were closed and the doors also. At last the mounted police by several flank movements managed to break up the crowds (also some heads) and cleared the streets. Altogether it was an exciting time; and I still retain my special constable's truncheon as a memento.

Some of my experiences have been tragic as well as humorous. I was once directing some alterations and crosses at a pole on the North London Railway, which was clipped to the viaduct wall of the line overhanging Chalk Farm Road. A wireman went up the pole, and as he leaned over to fix his vice and tongs to a wire I noticed a strange look in his face, and as he suddenly let go his tools and began to quiver I came to the conclusion that he was in a fit, and called to the lineman who was close at hand. He mounted the pole very quickly and lashed the poor fellow to the pole until his struggles and convulsions ceased, when we lowered him to the ground with a line and carried him to a place of safety. It was an exceedingly narrow escape from either falling into the street below (where a great crowd had assembled), or falling to the metals, where trains passed every few minutes. Needless to say, that man was not allowed to work up a pole again but was found employment as a battery-man.

(To be continued.)

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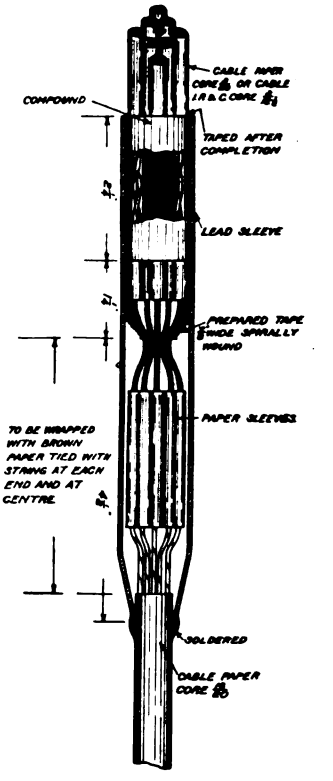
POTHEADS AND POTHEAD INSULATORS.

By E. GOMERSALL.

THE methods of terminating paper insulated cables for connection to open wires or to distribution frames or other apparatus have in the past been the source of much discussion, and consequently a description of methods recently adopted with success will probably be interesting to many readers of the JOURNAL.

Potheads of the form I propose to describe are suitable for terminating underground or aërial paper-core cable or silk and cotton-core cable, and the distributing wires may be lead-covered paper or I. R. & C. core cables, flame-proof, I. R. & C., or V. I. R. wire as may be desired. 1 illustrates a pothead for 16/20 paper-core cable with twin-wire lead-covered distributing cables. The method of making the pothead is as follows: The lead sleeve is dressed down at one end to a suitable size, and placed on the cable. The conductor joints are made between the cable conductors and the distributing wires, the completed joint being wrapped with insulating paper. The distributing wires are served with a wrapping of $\frac{1}{8}$-inch prepared linen tape, 1 to 2 inches wide, so that the sleeve, when slipped over, is a close fit. The tape wrapping is placed so that compound can be poured into the sleeve to a depth of at least two inches. The soldered or wiped joint is then made and the distributing cables at the other end of the sleeve are spread out so that the compound may find its way between them. Hot compound is poured into the open end of the sleeve, care being taken to fill it completely. The sleeve need not be warmed, but the compound must be hot enough to flow freely. When the compound has solidified the distributing leads are neatly bound with prepared tape close to and over the end of the cable. The most suitable compound for the purpose consists of 20 lb. G. P. scrap, 14 lb. resin, 14 lb. stearine pitch, with a little boiled oil added, if necessary, to temper the consistency.


CABLE PAPER CORE OR CABLE I.R.& C. CORE
COMPOUND
TAPED AFTER COMPLETION
LEAD SLEEVE
PREPARED TAPE WIDE SPIRALLY WOUND
PAPER SLEEVES
TO BE WRAPPED WITH BROWN PAPER TIED WITH STRING AT EACH END AND AT CENTRE
SOLDERED
CABLE PAPER CORE

I

When single or twin lead-covered cables are used for the distributing leads, the tape wrapping should cover the stripped ends of

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the wires, as well as a short portion of the lead sheathing. The sleeve should be marked with a scratch to indicate the top of the tape wrapping.

Perhaps the chief defect of potheads of other forms is that access to the joints cannot be obtained without destroying the pothead; cable terminal boxes have been largely used to overcome this difficulty. Potheads made as described are, however, free from this defect. To get at the joints it is only necessary to sweat off the soldered joint and gently warm the upper portion of the sleeve so as to soften the compound enough to permit of the sleeve being slipped down; if the operation is skilfully performed, only the outer surface of the compound will soften. When the sleeve has been soldered in position again, the warming of the upper portion will be sufficient to melt the compound and make it an air-tight plug. With careful workmanship these potheads will withstand an air-pressure of 20 lb.

Apart from the merit already mentioned, the introduction of the pothead described permits of cables being terminated without the need of stores which have to be specially manufactured, and the process is less costly than cable terminal boxes or solid plugs of cast lead. Lead-covered distributing wires can be employed instead of perishable indiarubber-covered wire, and the lead-covered cables are not so liable to break as in plugs of cast lead. Possibly with a little modification the pothead can be adapted for distributing cables in footway boxes.

Pothead insulators.—When it is desired to connect an aërial or underground paper cable to open wires, lead-covered single or twin paper core, or I. R. & C. core, cable should be used for the leads, terminated in pothead insulators. This insulator is designed with a screw cover for the top, and, under the cover, a cavity with two holes through the body of the insulator between the shed and the spindle, and a third hole to the groove for the line wire. The insulators are made in two sizes, for terminating light and heavy wires, the overall dimensions being $4\frac{5}{8}$ inches by $2\frac{3}{4}$ inches and 5 inches by 3 inches respectively.

The bare wire is terminated in the ordinary way. The lead-covered cable is brought up through one of the holes to the cavity at the top of the insulator. If a single wire circuit is being dealt with the lead covering is stripped to about $\frac{1}{2}$-inch beyond where it enters the cavity, and a sufficient length of wire is bared of insulation to allow of the wire being threaded through the small groove and soldered to the tail-piece of the open wire. As a rule 20 lb. conductors are used for single-wire circuits; the wire may be doubled back upon itself and twisted, or a separate short length of wire may be twisted up with it, where it is exposed to the atmosphere. Compound of the description already referred to is then poured

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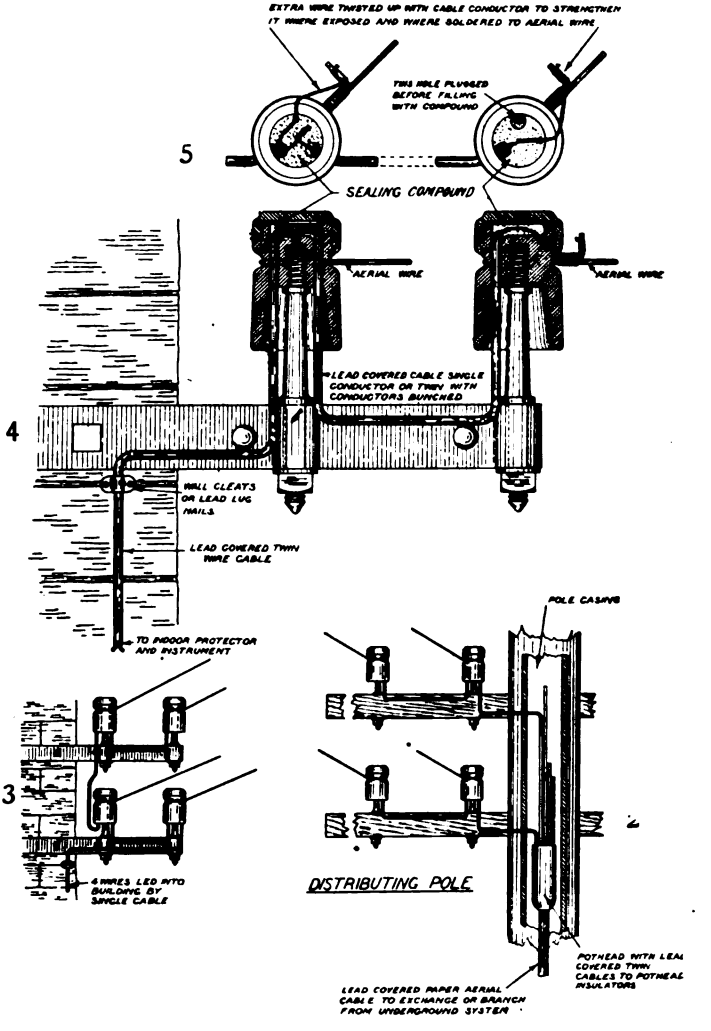
into the cavity to efficiently seal the cable, the unoccupied hole in the insulator being plugged.

For metallic circuits two insulators are required and twin cable is used. The cable is taken to the insulator nearer the pole casing, and one of the conductors is connected to the open wire as


EXTRA WIRE TWISTED UP WITH CABLE CONDUCTOR TO STRENGTHEN IT WHERE EXPOSED AND WHERE SOLDERED TO AERIAL WIRE
THIS HOLE PLUGGED BEFORE FILLING WITH COMPOUND
5
SEALING COMPOUND
AERIAL WIRE
AERIAL WIRE
LEAD COVERED CABLE SINGLE CONDUCTOR OR TWIN WITH CONDUCTORS BUNCHED
4
WALL CLEATS OR LEAD LUG NAILS
LEAD COVERED TWIN WIRE CABLE
TO INDOOR PROTECTOR AND INSTRUMENT
POLE CASING
3
4 WIRES LED INTO BUILDING BY SINGLE CABLE
DISTRIBUTING POLE
POTHEAD WITH LEAD COVERED TWIN CABLES TO POTHEAD INSULATORS
LEAD COVERED PAPER AERIAL CABLE TO EXCHANGE OR BRANCH FROM UNDERGROUND SYSTEM

already described. The other is soldered to the conductor of a single-wire cable or to the bunched wires of a twin cable, which is led from the insulator on which the other bare wire of the pair is terminated into the cavity through the second hole.

2 shows a pothead and the method of distributing subscribers' circuits radiating from a distributing pole. **3** illustrates a method

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of leading from a horizontal bracket, and **4** and **5** show the arrangements in the cavity at the top of the insulator.

On poles where the double-wire circuits are in diagonal positions, as at ordinary terminal poles, the short cables between the insulators may be protected from injury by the feet of workmen, by strips of wood fixed vertically on each side of the pole, close to the arms.

The cables between the insulators on 8-wire arms may be secured to the arm combiners. On arms where **J** cupholders are fitted it is convenient to fix the cables on the under side of the arms. Lead lug nails are suitable for the purpose. Where the cables enter pole-casing they should be taken through holes slanting upwards.

The insulator, as at first designed, had two cups, but as the lead-covered cable between the cups was itself earth connected, the inner cup did not serve any useful purpose and it has been abandoned. The single-shed insulators illustrated will withstand an electrical pressure of 25,000 volts between the groove and the spindle.

The foremost advantage of the new insulator is that it permits of inexpensive lead-covered cables being taken direct to the insulators on a terminal pole, or, at an office, direct from the insulator to the protective fitting inside. G.P. leads with leading-in cups on the casing, G.P. tails on small lead-covered cables, or perishable india-rubber-covered leads are no longer necessary, and in their place we have a neat arrangement of sealed lead-covered cables, which for this class of work may be considered imperishable, and the services of a skilled G.P. jointer are not required.

Probably the usefulness of the pothead insulator is not limited to the type described. An insulator with two side-knobs has already been designed, and possibly it may be found convenient and economical to distribute larger cables from pothead insulators of larger dimensions.

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THE TELEPHONING OF LONDON.

By W. Noble, A.M.I.E.E.

(*Continued from page* 22.)

Cables and Cabling.—At the outset of the telephoning of London the maximum sizes of cables adopted by the Post Office were 108-pair, with 40-lb. conductors for junction cables, and 217-pair, with 20-lb. conductors for subscribers' circuits, the last-named being increased later to 306-pair with 20-lb. conductors. More recently still the maximum size of subscribers' cables for short lines has been increased to 606-pair with 10-lb. conductors because experience had shown the possibility of using 10-lb. conductors, on lines having a total resistance within the 300-ohm limit allowed for local circuits. For short-distance *junction* circuits a reduction has also been made, from 40-lb. to 20-lb. conductors.

Another advance has taken place, viz. in the length of sections. At the commencement of the work the average distance between manholes was 150 yards, the standard is now 170 yards, increased in special cases to 180 and even 200 yards. The increase in the length of the cabling section was rendered practicable by the utilisation, some seven years ago, of the improved wire grip, which the writer had seen in Brussels. The employment of this grip has also effected an economy in time and material.

Portable Desiccators.—One appliance indispensable in the laying and maintenance of paper-core cables deserves mention, although it is now too well known to need description in this article, viz., the portable desiccator, which has aroused so much curiosity and wonderment on the part of London's millions. This machine was designed by the Post Office. The first type was hand-driven, the later type motor-driven. (1)

Besides being used for the drying-out of cables these desiccators are employed for making an air-pressure test on new cables, the electrical tests made on the completion of a main cable being followed by an air test. At the home end of the cable the air pressure is raised to about 30 lb., and when at the distant end it has reached about 20 lb. the desiccator is stopped. The pressure is allowed to equalise, generally reaching to about 25 lb. With gauges in at both ends the cable is left for 24 hours, and if the cable and jointing be sound throughout no fall in pressure should manifest itself.

Distribution.—Prior to the Post Office taking in hand the telephoning of London, distribution wholly underground had not been adopted by any administration. In America and some continental countries, where underground main cables had been employed,

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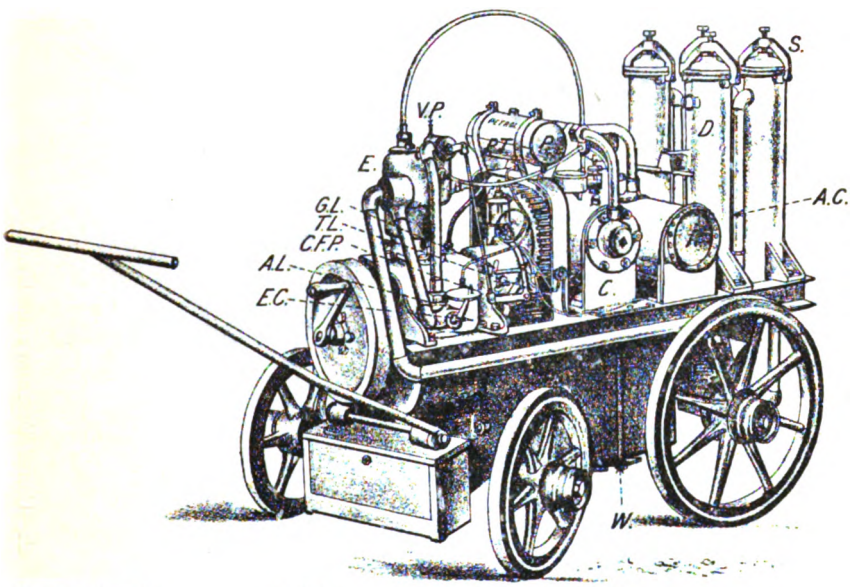
the distribution was effected either by a system of short open lines radiating from a ground-pole or roof-standard to which a main cable had been laid—sometimes called the "island" system of distribution—or by means of covered wires attached to the back walls of buildings—known as the "block" method. The Post Office being the first to adopt underground distribution on a large scale was faced with the problem of dividing up main cables into small cables for distribution.

CABLE DISTRIBUTION HEADS.—In the system of distribution



E. Petrol engine.
C. Compressor.
R. Air receiver.
D. Desiccator cylinders.
P. Petrol tank.
S. Spider.
W. Water tank.
A.C. Accumulator and coil.
E.C. Carburetter.
T.L. Timing lever.
G.L. Governor lever.
A.L. Air lever.
C.F.P. Carburetter float pin.
P.T. Petrol tap.
V.P. Valve pin.

1.—MOTOR-DRIVEN DESICCATOR.

introduced the main cables terminate in cable distribution heads, from which radiate distribution cables of the standard size of 7-pairs. One or more main cables terminate in a head into which are fixed gun-metal linings containing a number of 7-pair cables equal in total pairs to the size of the main cable. A description of the cable distribution head is unnecessary, but an interesting case illustrating its use is shown in **2** which is self-explanatory.

FOOTWAY PIPES.—The method of distributing along footways is illustrated in **3**. Connecting each manhole to the adjoining footways are three pipes, of 3-inch diameter in the outlying districts, and 3¼ inches in central London. These pipes terminate in double

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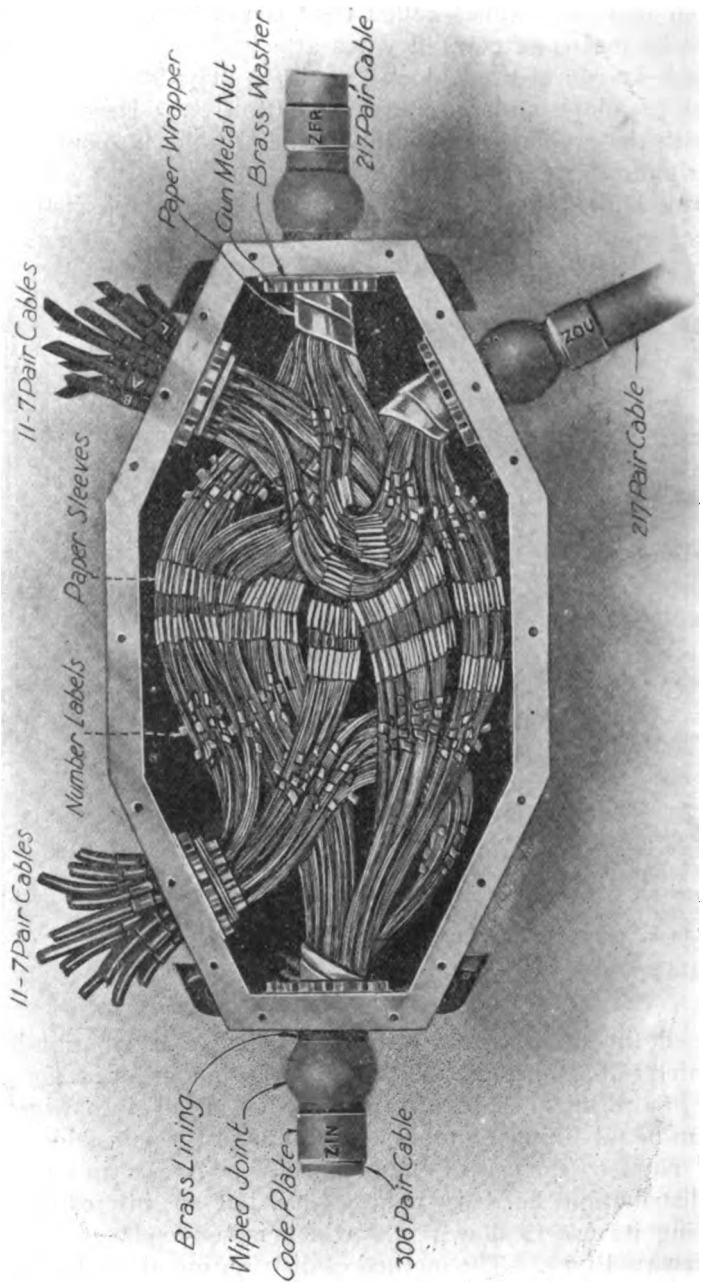

2.—Cable Distribution Head.

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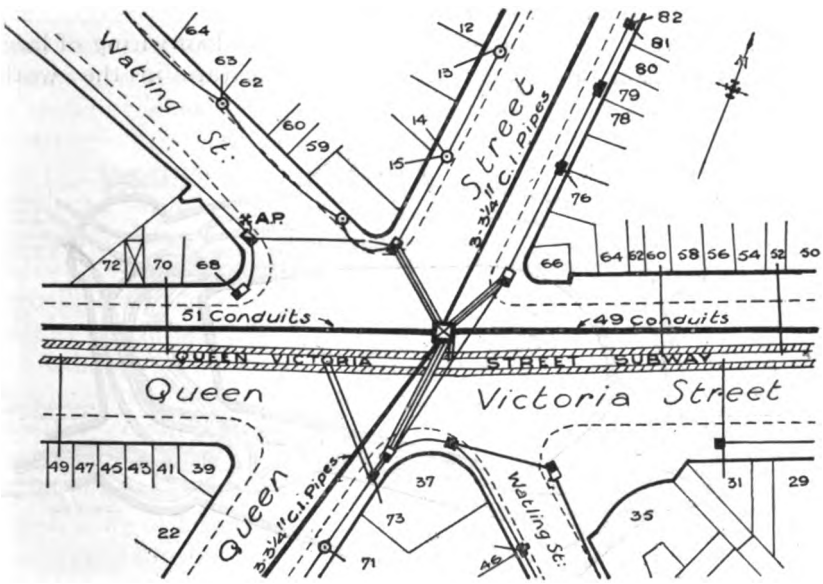
junction boxes, about 4 feet 3 inches in length by 2 feet in width. From these boxes pipes branch in different directions. The illustration given shows a typical case in the Central District, and indicates service from a subway.

SUBWAYS.—There are in Central London a number of subways, and of these every possible advantage was taken for the accommodation of cables. The most interesting subway is that built by



3

the Central London Railway Company at their Bank Station. Fig. 4 shows a plan of this subway and the disposition therein of some of the Post Office cables.

DISTRIBUTING JOINTS.—As the cable distribution heads provide for the sub-division of the main cables so provision is made for the diversion of the 7-pair and smaller cables by means of what are generally termed "*solid-joints*," of which there are four classes, the combinations being: 4 + 3, 4 + 2 + 1, 3 + 3 + 1, and seven single pairs. The one generally used is the last-named. It consists of six single pairs of lead covered cables grouped round one single

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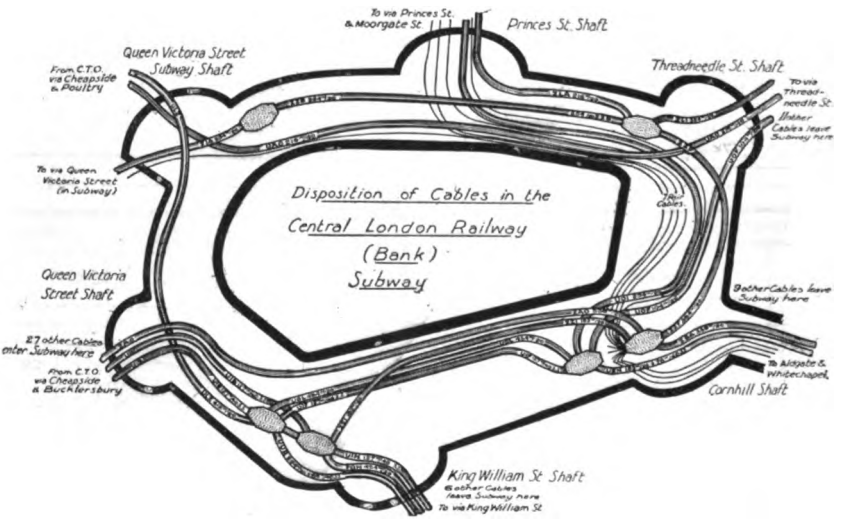
pair in a solid plug of lead. To one end is jointed a 7-pair cable, the other end being free to provide for seven separate subscribers. If at the outset only one or two circuits are required at a point, one of the other classes of solid joint may be connected up or a double single-pair solid may be used. Later, as the service grows, another 7-pair cable may be laid and the whole of the first cable left for distribution at the original point. This form of distributing joint provides all the elasticity that is desirable in a new telephone system, but it has one inherent defect—the single pairs with their thin lead covering will not stand rough handling.

INDOOR WORK.—As might be expected the indoor wiring of large buildings in London formed an important feature in the work.


To via Princes St. & Moorgate St.
Princes St. Shaft
Queen Victoria Street Subway Shaft
From C.T.O. via Cheapside & Poultry
Threadneedle St. Shaft
To via Threadneedle St.
Other Cables leave Subway here
To via Queen Victoria Street (in Subway)
Disposition of Cables in the Central London Railway (Bank) Subway
Other Cables
Queen Victoria Street Shaft
27 other Cables enter Subway here
From C.T.O. via Cheapside & Bucklersbury
Other Cables leave Subway here
To Aldgate & Whitechapel
Cornhill Shaft
King William St. Shaft
6 other Cables leave Subway here
To via King William St.

4

Various methods were adopted to meet the different conditions; three of the most important may be referred to.

First, in damp basements or where the main distribution has to be effected in front areas, a cable distribution head is installed and 7-pair cables run to the various floors. Then at convenient points they are sub-divided either by solid joints or at small test cases. A second method consists in the erection in the basement of an iron distributing frame (similar to the main frames in exchanges), from which run lead-covered cables or I.R. & C.C. leads in casing or conduits. In the third and most commonly employed system, a main cable is terminated at a distribution case of a size to meet the ultimate requirements of the building, and fitted with a number of connection strips to meet the present requirements.

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The fixing of casing or conduits in hundreds of large buildings in central London occupied continuously a staff of experienced carpenters for over two years, provision wherever possible being made to meet future requirements over a long period of years. Many of the buildings dealt with contain at least 100 rooms, many over 200, and in one case the number reaches 660, and yet another, 800 rooms.

EXCHANGES.—At an early stage in the preparation of its scheme it was necessary that the Post Office should decide the question of the Exchange system to be adopted. A study of the telephone situation generally showed the superiority of the Common Battery system over all others then in use ; there was therefore no difficulty in deciding that that system should be adopted for the larger exchanges.

The Department were the first to introduce and has consistently employed automatic signalling on subscribers' circuits, and although not seeing its way clear to adopt the common battery system for exchanges of all sizes, it was decided that the principle of automatic signalling should hold universally, with the result that a common battery *signalling* system was adopted for the smaller exchanges.

Although the common battery system had already been fully developed in America, it was necessary, nevertheless, in order to meet the conditions in London, for the officers of the Post Office to devise numerous junction and extension circuit arrangements.

DIVERSION WORK.—No paper touching on the history of the telephoning of London by the Post Office would be complete without a reference to what was commonly called the Diversion Scheme.

Although for distribution work many miles of new pipes had to be laid in footways, there had to be utilised for the purpose the large amount of existing pipes, all of which were already occupied by gutta-percha covered wires in use for telegraphs and an extensive private wire system. In order to utilise these pipes it was necessary first to divert the working circuits from the gutta-percha covered wires into paper-covered cables. That this was no light task may be gathered from the fact that over 5600 miles of gutta-percha wire was re-covered in Central London alone. Some 5000 circuits had to be kept working while the transfer was in progress, and as it was necessary that the work should be carried out in short sections, the number of changes on each circuit per mile did not average less than ten, making some 50,000 changes in all. When it is remembered that the circuits changed over included not only all provincial as well as continental circuits, but the Metropolitan Fire and Police services, the care required in carrying out the work can be realised. Further, the situation was rendered the more difficult from the fact that on certain routes no second pipe was available, and various methods had

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to be adopted to clear the pipes of gutta-percha covered wires, as interruption cable could not be used in City streets.

The diversion work was one of the largest ever undertaken by the Engineering Department. In the Central District alone about 150 men were continuously engaged on it for over two years.

STATISTICS.—As giving some idea of the extent of the Post Office Telephone operations a few statistics of the outside plant in Central London alone, may be given:

Mileage of earthenware ducts and pipes . .	718
,, ,, main cable	384
,, ,, ,, ,, wires	151,079
,, ,, distribution cable	1,689
,, ,, ,, ,, wires . . .	23,649
Number of manholes	619
,, ,, footway boxes	23,635

In this article no attempt has been made to do more than furnish the briefest possible outline of the work carried out by the Post Office in its share of the telephoning of London. To have embarked on details would have entailed the expansion of the article far beyond the limits of space allotted, and the writer must refer interested readers to his articles on the subject in the 'Electrical Magazine' for August, September, and October, 1904.

PROGRESS OF CONSTRUCTION WORKS.

DURING the month of March approximately 2100 poles and 1500 miles of wire were erected by the Department. In April approximately 1800 poles and 1800 miles of wire were erected. H-poles are counted as 2. The figures are exclusive of ordinary renewals and strengthening works, and also minor works. About 90 per cent. of the work was for trunk telephone purposes.

UNDERGROUND LINES.—Forty miles of pipe was laid in the month of March in connection with the extension of the main underground telegraph system. Twenty-two miles of cable were drawn in. About 17½ miles of pipe were laid, and 20 miles of cable drawn in during April. The figures include work done on the new underground routes between Manchester and Warrington, Birmingham and Bromsgrove, Durham and Stockton, Bristol and Falfield, and Exeter and Tavistock.

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RICHMOND TELEPHONE EXCHANGE NEW C.B. EQUIPMENT.

By J. W. Turner, A.I.E.E.

It is expected that the new C.B. equipment which is to replace that of the C.B.S. type in use at present will be ready for service in July. A brief summary of the principal features may therefore prove interesting.

The exchange building is situated at 21 & 22, The Green, and was originally two residences. The capacity of the new equipment

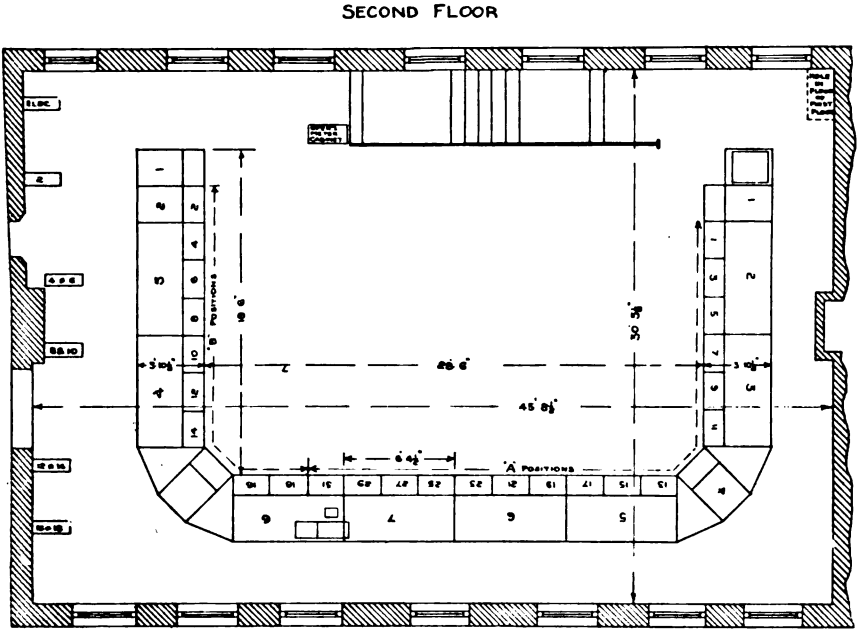

Fig. 1

will be for, approximately, 2500 subscribers' circuits, and to cater for this equipment it has been necessary to remove the two stairways and build a central stairway to serve both houses jointly. The third (attic) floors of the two residences and the party wall between the rooms on the second floors have been removed, and in the large and lofty apartment thus formed the switchroom equipment will be placed.

Fig. 1 shows the proposed lay-out of the sections, and it will be observed that provision is made for 16 "A" and 9 "B" positions. Apparatus racks are to be provided for the "B" positions only.

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Through the hole in the floor immediately below the rear of the last "A" position will be brought the repeating coil cables, and the multiple and other cables will arrive at the switchboard *via* the hole beneath the cable-turning section adjacent to the first section.

GROUND FLOOR

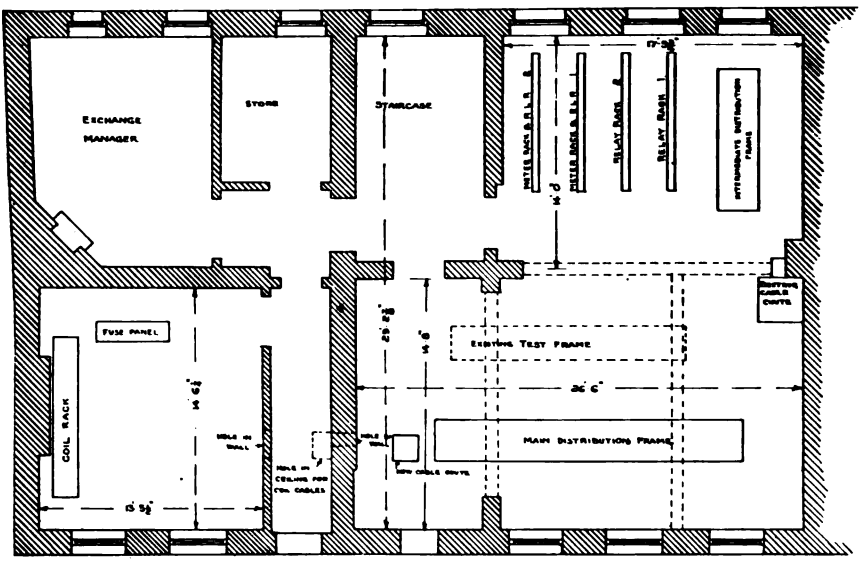
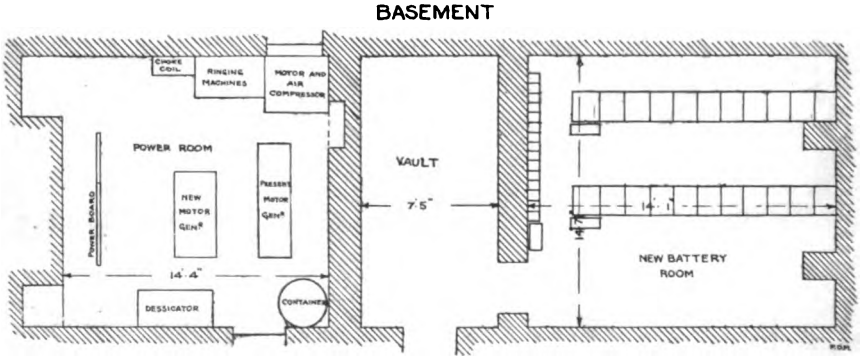


FIG. 2.

BASEMENT



3.—RICHMOND TELEPHONE EXCHANGE.

The suite of rooms upon the first floor is set apart for offices and operators' quarters, whilst the ground-floor, with the exception of the Exchange Manager's room, will be devoted to frames, racks and other test-room equipment. The apportionment of the ground-floor is given in Fig. 2. The existing C.B.S. test frame will be taken down when the C.B. equipment is brought into use. Two racks are

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to be provided for meters and resistance lamps. The meters, all of which will be within the range of convenient reading from the floor, will be mounted upon the lower portion of each rack, and the resistance lamps (300 to each bay) will be accommodated above.

The power and battery rooms are shown in Fig. 3. As far as possible the existing power plant will be utilised for the new equip-

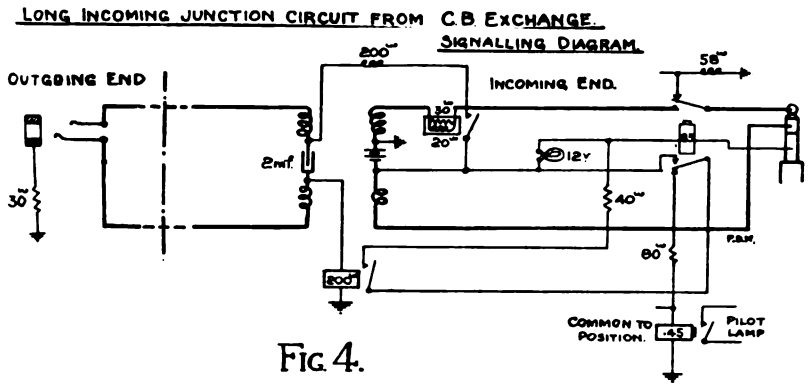

Fig. 4.

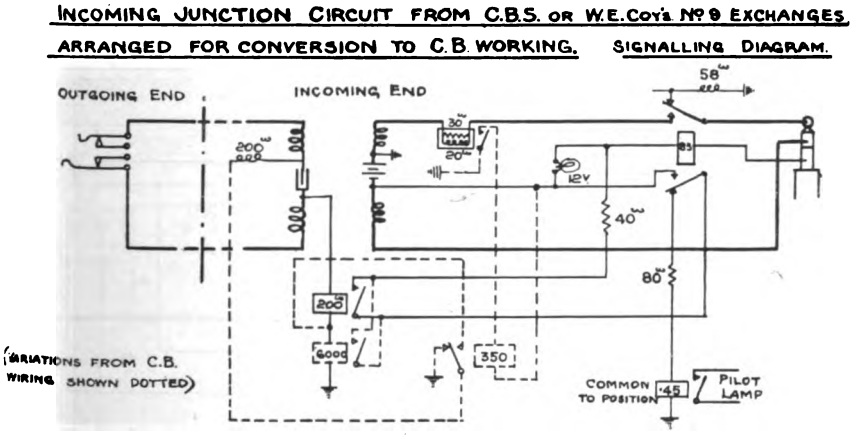

Fig. 5.

ment. It will be necessary, however, to instal new batteries, an additional motor-generator set and two ringing dynamotors, also to replace one of the panels of the power board by another of larger dimensions for the accommodation of interruptor and ringing switches, etc. The main batteries will consist of cells having an equipment of plates for an output of 480 ampère-hours at the nine-hour discharge rate. The boxes, however, will be large enough to take plates for an output of 720 ampère-hours at the same discharge

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rate. A meter battery consisting of fifteen cells of 60 ampère-hour capacity will be provided.

A cursory examination of Figs. 4 to 8 will reveal the fact that the signalling circuits on the junctions are to receive considerable modification. A new circuit for *long* incoming junctions from C.B.

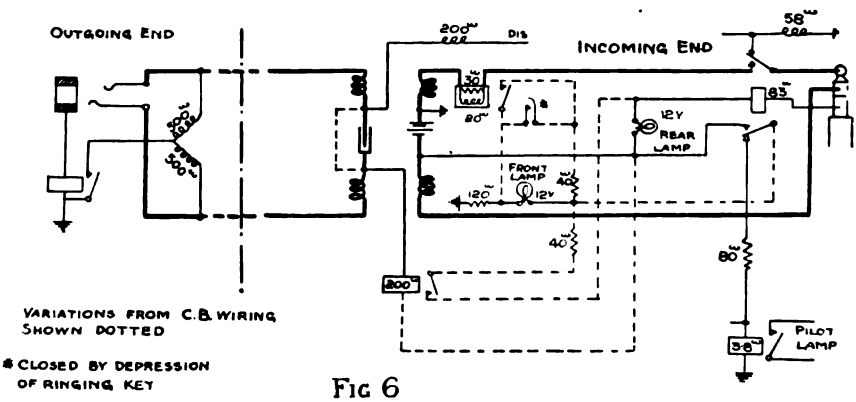

Fig 6

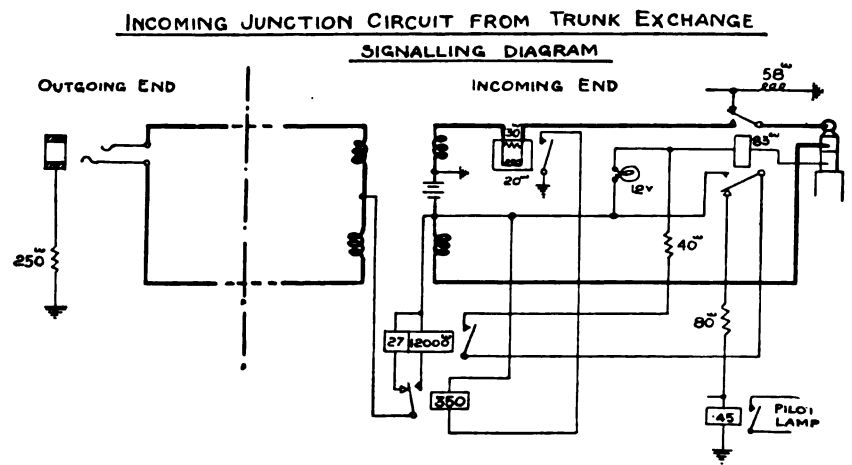

Fig. 7.

exchanges is shown in Fig. 4. In Fig. 5 a junction circuit incoming from either C.B.S. or W. E. Coy's type 9 exchanges are given. This and the incoming junction circuit from a magneto-exchange (Fig. 6) are arranged for ready conversion to C.B. working. In both diagrams the variations from C.B. wiring are shown by means of dotted lines.

A new feature is in evidence in the operation of the incoming

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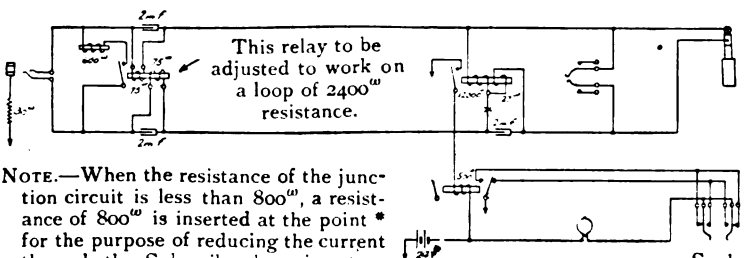
junction from the trunk exchange (Fig. 7). It is arranged that if the trunk operator withdraws the junction peg from the jack at the trunk exchange before the called subscriber has replaced his receiver, the incoming junction or "B" operator receives a clearing signal. The 27ω coil of the 12000ω + 27ω relay hitherto used by the Department upon incoming junctions from C.B. exchanges is not sufficiently sensitive for operation upon this circuit, and the Western Electric Coy.'s type, 2002A relay, having windings of the same resistance values but more sensitive in operation will, therefore, be employed.

Skeleton diagram of Junction circuit outgoing to Magneto Exchange, arranged for automatic signalling, and with long distance equipment at the outgoing end. Condensers in Subscribers' bell circuits.



NOTE.—When the resistance of the junction circuit is less than 800ω, a resistance of 800ω is inserted at the point * for the purpose of reducing the current through the Subscribers' receiver to a minimum, except in the case of exchanges where the Subscribers' receivers have been connected suitably as regards polarity.

FIG. 8.

MONITORS CIRCUIT. SUBSCRIBERS BOARD

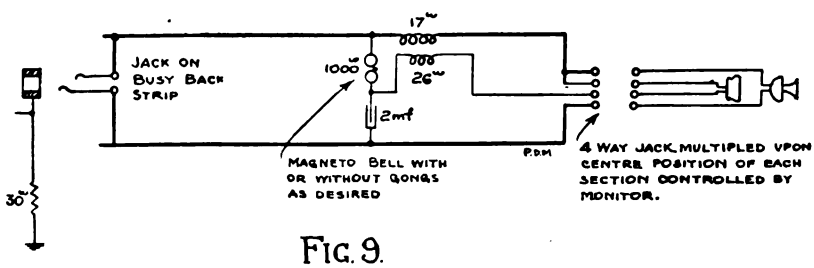


FIG. 9.

Fig. 8 shows an *automatic* outgoing junction circuit to a magneto exchange. This circuit provides for double supervisory signals at the "A" operator's position in the C.B. exchange. It will be observed that a condenser is necessary in the bell circuit of all subscribers' instruments connected to the magneto exchange.

The circuits shown in Figs. 7 and 8 were first introduced by the National Telephone Company.

Monitors' desks will not be provided. Facilities for the monitors making and receiving calls will be provided on the sections. The circuit for the "A" operators' monitor is given in Fig. 9. Calls

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originated by the monitor will be dealt with either by the monitor herself or by an operator at her verbal request, so that the provision of calling facilities is not necessary. The monitor controlling the junction positions will be provided with a circuit similar to that shown in Fig. 9, except that instead of the lines terminating upon a jack in the "Busy Back" strip, they will be extended to the I.D.F. for connection to a subscriber's line circuit.

The testing circuit for the Engineer's Desk is to be slightly modified by the introduction of (1) a combined key for speaking tests, (2) a voltmeter reversing key to enable "foreign" negative voltages between either A or B lines and earth to be detected, and (3) a key for the application of the "Howler" circuit.

In connection with the pending change from C.B.S. to C.B. working at the Richmond and Kingston exchanges, it will be necessary to make several temporary alterations to the C.B. exchange equipments and to some of the subscribers' C.B.S. installations; but owing to space limitations an account of these and of the arrangements for the transfer of subscribers' lines to the new C.B. exchanges must be reserved for a subsequent issue.

EXCHANGE WORKS IN PROGRESS.

TRUNK EXCHANGES.

THE following new, or additional, trunk exchange equipments are in progress:

	Trunk operators' positions.	Number of trunk circuits.
London Trunk Exchange	46	230
Manchester Trunk Exchange	46	230
Liverpool Trunk Exchange	84	420
Sunderland Trunk Exchange	4	20

The whole of the above work is being carried out by the British Insulated and Helsby Cables.

LOCAL EXCHANGES.

The following new exchanges are now in course of erection:

	Capacity, subscribers' lines.
Glasgow	10,000
Kingston	2,700
Finchley	1,000
Barnet	300

The undermentioned exchanges are being extended to their ultimate capacity:

	Ultimate capacity, subscribers' lines.
Hampstead	7,200
Victoria	5,400
Western	5,400

The Glasgow installation is being erected by the General Electric Company, Ltd.; the other six are being carried out by the Western Electric Company.

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ARMY FINANCE.

By CHARLES HARRIS.

Abstract of Lecture delivered at the Staff College, November 23rd, 1907.
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By "Army Finance" is meant, simply, the system of control of army expenditure. In order to guard against misappropriation, a searching and independent audit of expenditure is carried out by the Comptroller and Auditor-General and his department, independent of all the King's Ministers—even the Lords of the Treasury—and responsible to the House of Commons alone. To this officer the War Office has to render annually accounts showing how much was actually spent under each vote and sub-head of a vote; and his examiners are located in the War Office itself, as well as in the military commands, and have power to call for all books and papers connected with the expenditure included in the accounts. The primary object of the accounts is to show that the money spent has in fact been appropriated to the purposes for which the several votes were granted, and for this reason they are called Appropriation Accounts; but they also show a comparison between the money voted under each item of the estimates and that actually spent, and contain explanations of all the differences.

Parliament does not accept a small variation, either more or less, between the estimate and the actual result, provided there is a reasonable explanation, but insists that there shall be no excess on any one vote. If the total expenditure cannot be kept within the total of Army Votes, then the Secretary of State must submit to the House a Supplementary Estimate, before the close of the financial year, to make up the difference. If the excess expenditure on some votes is balanced by savings on others, then the War Office must write to the Treasury, satisfy them that the excess was unavoidable, and beg them to give temporary sanction to defray the excesses out of the savings on other votes; and later, when the accounts have been closed and the exact amounts of the excesses are known, the figures are formally reported to the House of Commons, and a clause inserted in an Act of Parliament (called the Appropriation Act) solemnly sanctioning the appropriation of the money so spent. If the War Office thinks it has enough money to last for the year, and therefore takes no supplementaty estimate, and then after all spends more than the total of Army Votes, the Secretary of State must submit to the House what is called an Excess Vote.

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Decentralisation in matters of finance is an attractive doctrine; but however decentralised the actual spending of the money may be, the money spent ultimately centralises itself in the columns of the War Office ledger, and unless there is a good deal of central control it is not to be expected that the figures in that ledger will agree with those in the Parliamentary Estimates.

An important result of the system of Appropriation Accounts is that the arrangement or structure of the Estimates must be such that the expenditure can be shown in the accounts in direct comparison with the heads under which the money is voted. You can arrange or classify expenditure in two ways—according to its *nature* or according to its *purpose*. Thus you buy coal to run an electric lighting plant for a hospital, or you buy coal to run machinery in an ordnance workshop. In either case the nature of the expenditure is the same—a purchase of steam coal; but the purpose in one case is the care of the sick and in the other the repair, say, of artillery equipments. Similarly, you buy hay which may be eaten by a troop horse or by a horse hauling building materials. So far as estimates go, there is no more difficulty about arranging your expenditure according to purpose than according to nature: you can either group all the expenses of cavalry, infantry, hospitals and so on, under those heads, or you can group all pay together, all forage, all building work, all fuel and so on. The former method would make the estimates far more significant and intelligible, and I have been very much struck by the extent to which the German Army Estimates followed this plan; but in Germany they do not have to publish Appropriation Accounts, and the necessity of doing this compels us to adopt the second plan. For when you pay your bill for coal or for hay, you can write down the one as fuel and the other as forage at once; but you probably do not know what engine will be run with the coal or what horse will eat the hay. Our estimates, therefore, are arranged according to the *nature* of expenditure and without reference to its *purpose;* so that our accounts, which follow the arrangement of the Estimates, do not show the cost of any service, department, or branch of the army, or any other result of which the mind can lay hold as throwing light upon the economic merits of army administration.

Of course it would be within the reach of the science of accounting to keep books showing what each unit of cavalry, infantry and the rest cost in the year; what was the cost of a horse-transport or a mechanical-transport company of Army Service Corps, and how many tons each carried in the year; what was the cost of an ordnance depôt, and how much stuff passed through it in the year; and other results of that kind. These would approximate to commercial accounts; but only in one army department are anything

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that a business man would call accounts kept, and the difference between such accounts and Parliamentary Appropriation Accounts is well shown there—that is, in the Factories at Woolwich and elsewhere. The Appropriation Account for the Factories merely tells you that a million *odd* was spent on wages and a million *odd* on materials, without the faintest indication of what was got for the money. The manufacturing or business accounts tell you in detail all the stores produced, with the cost price of each; so that you can see that your new field gun cost so much and its carriage so much, and can judge on the one hand whether your contractors are charging you a fair price for the same thing, and on the other whether your gun factory is being economically run.

If you take a big business concern, such as a railway, you will find that the responsibility of the head of a department is brought home to him by means of accounts of this type—accounts which work to the cost of some economic unit, such as the train-mile, the passenger-mile, and so on. That man's promotion and future depend upon the results the accounts show, and if his costs are going up he has to answer for it to his directors, and they in turn to their shareholders. The directors, on the other hand, knowing that in the accounts they have the means of gauging his management and bringing him to book, can give him a free hand in his department; and these two factors, the free hand and the liability to be called upon to answer for the results obtained, together constitute real responsibility. But army accounts afford no indication whether administration is economical or not, and consequently the liability to be called to account, slips into the background, and the phrase "financial responsibility" is often used to denote simply the power to spend the public money unquestioned.

The bedrock principle of our national system of finance is that unless a special Act of Parliament to the contrary is passed, as is done when loans are raised, the expenditure of the year must be defrayed out of the taxation of the year; and any proceeds of taxation not actually spent in the year revert to the Exchequer and are applied to the reduction of the National Debt. Every shilling of the votes of this year that has not been actually spent by the 31st March next will have to be surrendered by the War Office to the Exchequer. In this way every year starts on the 1st of April with a clean slate, and there is no carrying over of unspent balances from one year to the next. Unfortunately, we cannot wipe the slate of liabilities in the same way, and it often happens when there are heavy contracts running for guns, building work, and so on, that the rate of progress turns out to have been overestimated and money is surrendered unspent at the end of one year which has to be paid in the following year, when it has not been taken in the Estimates

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and has to be "sweated" somehow out of the new year's programme.

Treasury control is exercised over expenditure in bulk and in certain respects over details. It is obvious that there must be a department to bring together the estimates of all the spending departments and review them as a whole before the Government can settle its financial policy for the year. All annual estimates have therefore to be submitted to the Treasury, and of course sufficient cause must be shown for important increases. But it is not enough to watch and control the immediate growth of expenditure: a most insidious form is that which adds little or nothing to the present votes, but pledges those of future years. For instance, when service pay was introduced there was no charge at all for the first two years, but men were being enlisted with rights to the extra pay all the time, and after two years the charge grew rapidly to over a million. The Treasury therefore requires all changes in numbers and rates of pay or pension to be submitted specially to it for approval; but expenditure on stores, which is generally non-recurrent as well as technical, is less closely controlled. Generally speaking, the Treasury works by regulation, and though these regulations are not orders of Parliament, the House of Commons takes cognisance of them, and insists on their being obeyed. For this purpose the House requires the appointment of an Accounting Officer, who is responsible to Parliament that all the expenditure of the army is conducted according to these regulations, and has to certify the annual account to the effect that all expenditure requiring authority higher than that of the War Office has been so authorised. To enable the Accounting Officer to carry out these duties, all payments are either made or audited by officers directly responsible to him, and if any payment is in his judgment contrary to regulation it is his duty to refuse to allow it; that is, if the money has not been paid to refuse to pay it, or, if it has been paid, to refuse to include it in the account and charge it back to the person who paid it. In thus refusing, he can only be overruled by the written order of the Secretary of State himself, who then becomes directly responsible to Parliament for the expenditure in question. The Accounting Officer in the War Office is the Director-General of Army Finance; but this rigid control over the public money is not peculiar to army affairs: in every department of the State there is an Accounting Officer with similar functions. I said a little time ago that true responsibility consisted of two elements: power to act, and liability to be called to account. The arrangements I have just described give the Accounting Officer the necessary power to secure the regularity of expenditure; the other element is supplied by the fact that every year, when the Comptroller and Auditor-General has

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audited the accounts and reported on them to Parliament, the Accounting Officer is called before a Committee of the House of Commons, the Committee of Public Accounts, there to answer for the whole expenditure of the army, and to make his defence for all that the auditor may have found to criticise.

At the head of the Finance Department is the Financial Secretary to the War Office, or Finance Member of Council, a Member of Parliament, with the Director-General of Army Finance, who holds the post of Accounting Officer, as his immediate assistant. Under the Director-General come three Directors—of Financial Services, Army Accounts, and Contracts. The duties of the Director of Contracts, a post which has only just been revived after being in abeyance for some years, stand rather by themselves. The actual making of contracts, though in some former organisations it was under the Financial Secretary, was not under the Accountant-General (the officer whose work corresponded generally with that of the Director-General of Army Finance).

The two directorates are divided into a number of branches corresponding to certain classes of work: a branch for making issues of cash and keeping the main ledger from which the Parliamentary Appropriation Account is prepared; a branch for examining such cash accounts as are not examined locally; a branch for administering the personnel of the Accounts Department; a branch for questions of pay; one for pensions; four branches dealing with the expenditure and accounts of the spending departments, viz., Supplies and Transport, Clothing and Stores, Ordnance, and Works; and lastly, a branch for dealing with the establishment of the army and with estimates and expenditure as a whole. The head of each of these branches occupies a dual position. As an officer of the Director-General of Finance he is responsible to him, in his capacity of Accounting Officer, for the regularity of all expenditure, and also for seeing that he is kept informed as to any questions having an important financial bearing, in order that he may advise the Finance Member on them. But he is also financial adviser to the Member of Council administering the Army Votes for the expenditure with which he deals. In this capacity he gives the Member of Council, and the Directors and other officers concerned, all information about the financial bearings of any question that may come up, so that (as I said before) financial considerations may be borne in mind in the earliest stages of formation of opinion. He also assists the Directors and Member of Council in framing the annual estimates for the votes concerned and controlling the progress of expenditure under them, as may be necessary.

In the Commands also, the local head of the Finance Member's department, the Chief Accountant, as he is called, has a dual

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capacity. As financial adviser to the General Officer Commanding he is attached to the staff, and stands to the general in the same relation as the head of a financial branch in the War Office does to a Member of Council. On the other hand, as the local representative of the Accounting Officer he is directly responsible to him for cash duties, for the keeping of regimental accounts (now that the company commander has been relieved of that duty), and for the audit of accounts of all kinds; and in this capacity he is necessarily in direct communication with the Accounting Officer at the War Office, just as the Accounting Officer is a sense independent of the Army Council and in direct communication with the Public Accounts Committee of the House of Commons. That is, if a Chief Accountant should be ordered by a General Officer Commanding to make a payment which he believes to be contrary to regulation, he must state his objection in writing, and the General Officer cannot overrule the objection without reference to the War Office, the Chief Accountant then making his own report direct to the Accounting Officer. In the German army a similar relation holds good between a Corps Commander and the Chief Intendant of his command.

The expenditure of money—the purchase and manufacture of stores—cannot be conducted by regulation alone, and a control has to be applied. It is work of singular difficulty. Patterns are constantly changing; quantities change with the size and composition of the forces to be equipped, with changes in defence schemes, and so on; consumption is irregular; and, above all, when you have settled your programme for the year and got your estimates accepted, you are in the hands of the inventors and pattern experts on the one hand, and of the contractors who make the stores on the other. Long experience alone can enable you to discount the promises of these gentlemen sufficiently to spend your money, but not more than your money, by the end of the year; and this experience is supplied by the finance branches attached to the departments of the Quarter-Master-General and the Master-General of the Ordnance. These branches keep touch with all the orders given for stores, the deliveries and payments, so that they can advise the Directors and their assistants continually as to the progress of their expenditure, and can share with them the business administration of their votes, as distinct from the technical side of their duties.

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THE RADIO-TELEGRAPH CONVENTION—AND AFTER.

THE current quarterly number of the 'Edinburgh Review' (April, 1908) contains an interesting dissertation dignified by the title of "The Politics of Radio-telegraphy," which deals with the legislative aspect of wireless telegraphy. The position of the art in relation to the Wireless Telegraphy Bill, which allocated discretionary powers to the Postmaster-General in the matter of erection and scope of radio-telegraph installations in the United Kingdom, and to the wider and all-embracing Radio-telegraph Convention of international import, is discussed in a free and easy manner.

The adoption at an early date by this country of the tenets of the Convention, ushers in a new era for radio-telegraphy. It places the art under complete government control, with a view to obtaining greater utility therefrom in regard to its application for communication with, and between, ships at sea. For this purpose wireless telegraphy is now invaluable, and the convention should, therefore, on the face of it, fulfil a useful and admirable function, if its regulations are reasonably and judiciously applied. The duty of applying the Convention scheme is largely vested in the Postal Telegraph Administration in this country. Necessarily the Navy is vitally concerned, and the Admiralty will therefore hold at least a watching brief in the matter.

In the article mentioned, the contributor refers to the determined effort made by the Marconi Company to nullify the Convention, or, at least, to modify its terms very materially indeed before acceptance by this country, an action which resulted in the appointment of a Select Committee of the House of Commons to inquire into and report on the pros and cons of the question, prior to any further steps being taken by the Government. Subject to the finding of this committee depended the ratification or rejection of the agreement arrived at by the British representatives at the Berlin Conferences. The evidence of various witnesses, expert or otherwise, taken by the Committee is commented upon, and the contributor expresses his surprise that a more decisive majority in favour of ratification was not obtained. The greater part of the article may be characterised as a tirade against the Marconi Company and all its ways, and though one may feel disposed to agree in the main with the conclusions of its author, many of the statements made convey the impression that there is at root a tinge of venom. Moderation in debate might well be counselled in respect of such arguments; for instance, as those adduced to belittle the credit of Marconi and extol that of his forerunners in the region of purely physical research on electric radiation. It is no

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doubt true that, were it not for the genius of Hertz stimulated by the mathematical insight of Clark Maxwell, Marconi would not have been able to carry his invention into practice, but it may also be equally true that had the petrol motor or the screw propeller never been invented, nor the laws of air resistance investigated, the hope of a complete solution of the problem of aërial flight would be small indeed. The satisfactory solution, however, is not yet achieved, and surely it is still open to the man of inventive genius and perseverance who shall satisfactorily solve the problem to obtain great and lasting credit thereby, even though it consisted (and this is highly probable) only in the proper practical application of known principles. It is no doubt true that the apportionment of credit is seldom made in accordance with the intrinsic worth of the work done, but that is a lottery in which the losers have no course but to take their ill-luck with a good grace, which becomes them better than vain revilings. Belittle it as one may, it cannot be gainsaid that Marconi has a rightful due as the pioneer of *practical* radio-telegraphy. His forerunners made no real attempt towards practical applications. Those who have closely followed and emulated the development of the system from its first crude form must fain admire the plodding persistency by which success was ultimately achieved. The conditions necessary to enable the oscillation-transformer to be usefully constructed and made to increase the range and reliability of the receiver before the properties of resonant circuits had been systematically investigated or fully appreciated in this connection, either by himself or others, is a feat in which the practical insight and perseverance possessed by Marconi stood him in good stead, for there can be little doubt that innumerable trials and innumerable failures preceded success in this direction alone.

Turning now to matters of more practical moment, as represented by the application and operation of the convention itself; the radio-telegraph engineer will recognise that, contrary to what might be expected, it is not easy to bring the aims of the convention satisfactorily into operation. The subject has a complexity peculiarly its own, especially on the technical side—a complexity which has perhaps been imperfectly appreciated even by those who framed the terms of the Convention articles. To take one aspect of the case ; a fundamental object is to provide such a scheme of operation and organisation as shall enable the greatest utility to be obtained in the field of radio-telegraphy. To this end it is imperative that undue interference between stations be guarded against. In this relation the convention and its appended service regulations make provision under three heads, as follows:—

(*a*) Limitation of the electrical power taken by the radio-telegraphic plant.

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(*b*) Limitation of range of wave-lengths to be used for specified kinds of communications and a specific wave-length for a certain specific purpose.

(*c*) Use of "syntonised" or "tuned" systems only.

With regard to the first provision it is to be noted that though the power used is a factor in determining the amount of disturbance produced in the ether by the operation of emitting electric waves, it is by no means the only, nor perhaps the most important, factor. The same limit of power is to be observed for all types of transmitting appliances, and in this respect alone there is scope for the production of almost unlimited disturbance. The antenna may be high or low, an effective and powerful or a poor and feeble radiator even with the limits of wave-lengths and syntonisation prescribed. It is conceivable that an effective type of transmitter could be used which would efficiently convert the low-tension electrical energy from the source directly into effective high-frequency oscillations, thus avoiding the usual transformation and other losses which account for the absorption of by far the greater part of the energy used. For instance, an electrostatic machine of efficient design driven directly by a one-kilowatt motor would furnish a means of producing prodigious disturbance, though it might not lend itself well to signalling purposes. But more important still is the fact that the disturbance produced is an inverse function of the rate of sparking, and that a system absorbing one kilowatt of electrical energy may, by a scheme of slow laborious discharges, release Jove's very thunderbolts at each spark. Such a system, if utilised for, say, the transmission of messages over long distances, would constitute a grave menace to all other stations within its range using approximately its wave-length, not only in virtue of the heavy disturbance produced, but by reason of the prolonged period which would be occupied in spelling out its tedious messages. There is also the question of how this limitation of power is to be observed in such cases as the supply of energy direct from the mains of an existing electric installation for lighting and power purposes, or even the simple case of power taken direct from accumulators. In both instances there are practical difficulties in the way of ensuring that power very considerably in excess of the stipulated amount is not drawn, very probably in ignorance on the part of the operator or other responsible official, of the meaning of the expression "electrical power." The idea of fuses and cut-outs will no doubt occur to the practical engineer in this connection, but these devices as often as not quickly fall into disuse in the absence of a systematic overhaul and inspection, perhaps for no other reason than that they are a source of some occasional trouble, or because it is not apparent that they are essential to the good working of the station. A number of other

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factors also enter into the question of power limitation which would occupy too much space to discuss fully, but it will readily be seen that simple legislation for a stipulated limit of power is not by any means all that is required to check undue interference. The second provision mentioned above, viz. wave-length limitations, is more effective so far as the avoidance of interference between stations having different ranges of wave-lengths is concerned. The wave-lengths used for naval purposes may, for instance, be entirely outside the scale of wave-lengths allotted to commercial stations and the mercantile marine, thus in general ensuring a strictly limited interference area as between the two distinct systems. It will be observed, however, that this provision does not touch the question of interference between stations having the same scale of wave-lengths allotted to them. Fine discrimination in the allocation of wave-lengths is, moreover, at present a matter of impossibility, in the absence of a definite standard of wave-length measurement. No doubt this weakness will shortly be rectified. The third provision is open to the objection that it is extremely difficult to specify what is and what is not a "syntonised" system. "Syntony" and its co-related "resonance" are the very life and soul of all radio-telegraphy. Without invoking the aid of resonance effects and syntony it is not too much to say that high-frequency oscillations would not be amenable to the purposes of radio-telegraphy. Hence every system of radio-telegraphy extant is a syntonic system, and capable of being "syntonised." It is only a question of the degree to which this property is possessed that can differentiate a so-called "untuned" from a "tuned" system, and in this fact lies an obstacle to the introduction of an entirely satisfactory definition of the term. Without some kind of definition the provision is of course quite futile. Again, the syntonisation of radio stations to one another is mutual, that is, it is a joint function of the transmitter at the one station and the receiver at the other, and the degree of syntony is therefore determinable equally by the transmitter or the receiver. Strictly speaking, therefore, there should be a definition of a syntonised transmitter and a syntonised receiver. In this lies a possibility which appears to commend itself for adoption in lieu of a simpler and less involved definition, viz. that a transmitter be regarded as syntonised when the closed oscillatory circuit is coupled to the aërial system to just such an extent that under the best working conditions maximum range of communication is obtained, and that a receiver be likewise so regarded when its closed oscillatory circuit is coupled to the aërial system only to the extent necessary to ensure maximum range of communication. To make this clear it should be explained that the degree of coupling determines the freedom, or rather want of freedom,

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of the oscillatory circuit, and therefore the want of persistency of the waves generated in each train of an impulse, that is, the less the coupling between the oscillatory circuit and the aërial system the greater the persistency of the train of waves, and the sharper the tuning obtainable. The amplitude of undulation of the waves also suffers, however, so that a point is quickly reached when any weakening or lessening of the coupling reduces rather than increases the range of communication. It is true that in some transmitting systems there is no separate oscillatory circuit, the aërial system itself being made to fulfil the purpose. These would require to be specially dealt with from the point of view that they would be restricted to operate with only such power as would determine an interference no greater than that from a transmitter with coupled oscillatory circuit, properly adjusted as defined above.

So far interference between stations has been dealt with in this article mainly as a question of amount of disturbance imparted to the ether. But to make a complex question yet more complicated it has unfortunately to be recognised that the disturbance in the ether is only one factor in the interference problem. Disturbance may be defined as the maximum amplitude of wave-undulation generated. Interference between stations depends also on:

(*a*) Characteristics of wave-transmission.

(*b*) Characteristics of receiver.

(*c*) Location and proximity of stations.

With regard to (*a*) the length of wave has some bearing on the matter as long waves have a greater range than short ones, and some types of wave detectors are more responsive to long waves than short, and *vice-versâ*. Thus, the magnetic and electrolytic detectors are more responsive to long waves than the carbon-steel and other detectors of the coherer type. The damping co-efficient has also to be taken into account in that it affects the "percentage freedom" due to difference of tune. Next, and by no means least, is the intermittency factor, that is, the rate of succession of wave-trains emitted. With the auditive receivers now in general use the note due to the particular intermittency of the transmitter is quite distinctive, so that it is possible to read the signals from a particular station irrespective of other and possibly stronger signals audible from another station using the same wave-length, interference being in this way very greatly minimised. This feature becomes especially pronounced where rapid rates of sparking, which produce distinctive notes in the receiver, are concerned. In all such cases, however, thoroughly practised and expert operators are necessary to enable accurate and safe transmission to be accomplished under these conditions of interference.

With regard to (*b*) there are still more factors concerned, such

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as sensitiveness of receiver, degree of susceptibility to tuning, maximum amplitude required to effect response under specified degrees of dissonance of tune, method of response (auditive or recording), etc. In the continuous wave-systems which are now being developed there are yet other aspects of interference to be dealt with. The Peddersen "tikker" receiver owes its sensitiveness quite as much to its property of making use of a very long series of waves and storing the energy by cumulation as to its degree of susceptibility to tuning.

Directive systems of wireless telegraphy are also in course of development, and one at least is of such a nature that in a specified direction no interference whatever results. In other directions the interference varies with the angle to the direction of *nil* radiation.

Transmitters using coupled oscillatory systems emit subsidiary waves differing in length from the main effective wave. Likewise coupled oscillatory circuits in the receiver exhibit a degree of responsiveness to certain waves differing in length from those effecting the main response. Transmitters in which the aërial system is pre-charged and is the only part in which oscillations take place and receivers used directly in the aërial system are free from this defect, but introduce others which may in certain circumstances prove even more troublesome. Pre-charging of the aërial introduces trouble due to electrostatic induction over a certain range, similar to the interference produced by atmospheric electrical disturbances against which tuning is not altogether effective, because the conductors affected will always oscillate at their own particular fundamental rate whenever the electrostatic induction is suddenly diminished or suddenly increased. For this reason although subsidiary waves are not inherent to transmitters using pre-charged aërials they are doubtless liable to set up subsidiary waves by causing other conductors in the proximity, or even in the station itself, to emit waves.

That the location of a station with regard to the nature of its surroundings, hills, foliage, etc., will have an important bearing on the interference in different directions will be obvious.

Enough has perhaps been said to indicate the nature of the problems which have to be faced and much more thoroughly investigated than has yet been done if anything like exactitude is to be aimed at in defining interference between stations. To interpret and apply the terms of the International Convention in a reasonable and just manner involves a close engineering knowledge of the art, and the matter will require delicate handling. The Convention itself does little more than touch the fringe of the subject, and it is on its intelligent and reasonable interpretation that its usefulness will largely depend.

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ON THE PROPAGATION OF PLANE ELECTRO-MAGNETIC WAVES ALONG A PLANE CONDUCTING SURFACE, AND ITS RELATION TO WIRELESS TELEGRAPHY.

By J. ZENNECK.

(Translated by H. HARTNELL, A.M.I.E.E.)

A. PROPAGATION OF PLANE ELECTRO-MAGNETIC WAVES ALONG A PLANE CONDUCTING SURFACE.

THE following symbols will be used :

E = Intensity of electric field.
M = Intensity of magnetic field.
ε = Dielectric constant.
μ = Permeability.
σ = Conductivity.
$\nu = \pi \times$ frequency.
$\iota = \sqrt{-1}$.
$v = \frac{1}{4\pi}$ in C.G.S. system.

Quantities without suffix relate to the conductor, with suffix 0 to the air.

The author deals with the propagation of electro-magnetic waves along the surface of an infinite plane conductor, having considerable resistance.

This investigation is of great interest in the theory of wireless telegraphy. The cases of a perfect conductor and of a fairly conducting liquid mass, such as sea-water, have already been studied by E. Cohn and K. Uller.

1 *Fundamental Equations.*

Taking the direction of X, as shown by the arrow (Fig. 1) as the direction of propagation, and choosing the axes of co-ordinates as indicated, we may at once write :

(1) $\quad E_y = M_x = M_z = 0.$

The remaining components of the field will be affected by a factor F.

(1a) $\quad F = e^{\iota(\nu t + sx)}$

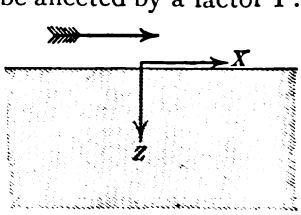
s being a constant to be determined.

Maxwell's equations are then :

$$(\sigma + \iota\nu\varepsilon)E_z = -v.\iota.sM_y,$$

$$(\sigma + \iota\nu\varepsilon)E_x = v.\frac{\partial M_y}{\partial z},$$

$$\iota\nu\mu M_y = v.\left(\frac{\partial E_x}{\partial z} - \iota sE_z\right)$$



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For air, their solution is of the form:

$$(2)\qquad \begin{cases} M_{0y} = a_0 e^{-\iota r_0 z}.\,\mathrm{F}, \\ E_{0x} = -\iota r_0 . \dfrac{v}{\sigma_0 + \iota\nu\varepsilon_0} . a_0 e^{-\iota r_0 z}\,\mathrm{F}, \\ E_{0z} = -\iota s . \dfrac{v}{\sigma_0 + \iota\nu\varepsilon_0} . a_0 e^{-\iota r_0 z}\,\mathrm{F}, \end{cases}$$

and for the conductor:

$$(3)\qquad \begin{cases} M_y = a e^{+\iota r z}.\mathrm{F}, \\ E_x = \iota r . \dfrac{v}{\sigma + \iota\nu\varepsilon} . a e^{+\iota r z}.\mathrm{F}, \\ E_z = -\iota s . \dfrac{v}{\sigma + \iota\nu\varepsilon} . a e^{+\iota r z}.\mathrm{F}. \end{cases}$$

Between the quantities r, r_0, s, we have the following relations:

$$(4)\qquad r_0^2 + s^2 = -\frac{\iota\nu\mu.(\sigma_0 + \iota\nu\varepsilon_0)}{v^2},$$

$$(5)\qquad r^2 + s^2 = -\frac{\iota\nu\mu.(\sigma + \iota\nu\varepsilon)}{v^2}.$$

The limiting conditions give also:

$$a = a_0,$$

$$(6)\qquad \frac{r_0}{\sigma_0 + \iota\nu\varepsilon_0} = -\frac{r}{\sigma + \iota\nu\varepsilon}.$$

From equations (4) (5) and (6) we have:

$$(7)\qquad \begin{cases} s = -\sqrt{-\iota a . \dfrac{(1+\iota q)(\beta + \iota q_0)}{(1+\iota q) + (\beta + \iota q_0)}}, \\ r_0 = +\sqrt{-\iota a . \dfrac{(1+\iota q)^2}{(1+\iota q) + (\beta + \iota q_0)}}, \\ r = -\sqrt{-\iota a . \dfrac{(\beta + \iota q_0)^2}{(1+\iota q) + (\beta + \iota q_0)}}, \end{cases}$$

Using for brevity:

$$a = \frac{\sigma\mu\nu}{v^2},\ q_0 = \frac{\nu\varepsilon_0}{\sigma},$$

$$\beta = \frac{\sigma_0}{\sigma},\quad q = \frac{\nu\varepsilon}{\sigma},$$

2. *Calculation of the Various Constants.*

The frequency in what follows is taken as 10^6/ sec ($\nu = \pi\ 10^6$/ sec), corresponding to a wave length in air of about 600 mètres. We shall show later how the curves drawn on this assumption may be used for other frequencies.

The conductivity of the conductor will be assumed to be between $\sigma = 10^{-9}$ and $\sigma = 10^{-17}$ C.G.S. The conductivity of a 5 per cent. solution of NaCl is about $0{\cdot}6 \times 10^{10}$ C.G.S., whilst that of dry sand is about 10^{-17}.

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The influence of the conductivity of the air is at first assumed to be *nil* ($\beta = 0$).

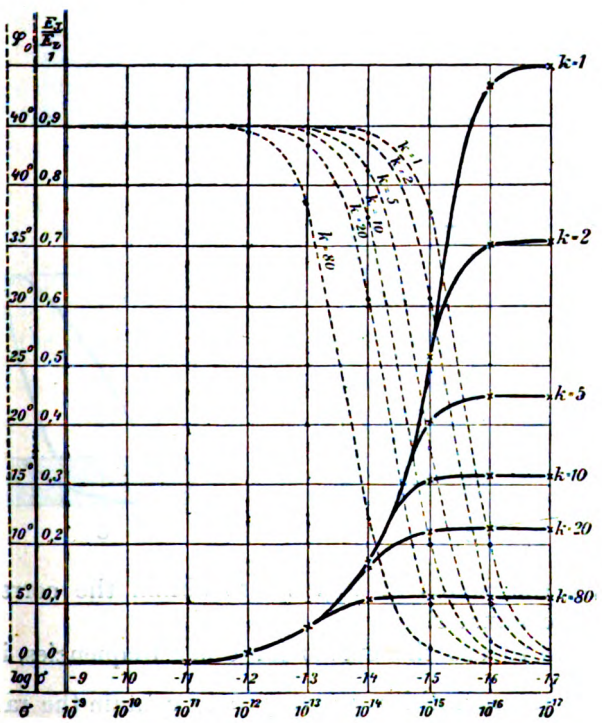
The dielectric constant of the conductor is assumed to vary between that of air and that of water. $k = \frac{\varepsilon}{\varepsilon_0} = \frac{q}{q_0}$ will consequently vary between 1 and 80.

3. *The Direction of the Electric Field.*

(1) Equations (2) and (7) give for air:

$$(8)\qquad \begin{cases} \dfrac{E_{0x}}{E_{0z}} = \dfrac{r_0}{s} = -\sqrt{\dfrac{\iota q_0}{1+\iota q}} = -\sqrt{\dfrac{q_0}{\sqrt{1+q^2}}}\, e^{\iota\phi}, \\ \tan 2\,\phi_0 = \dfrac{1}{q}. \end{cases}$$

($2\,\phi$ in the first quadrant).



2

The curves in Fig. 2 give the absolute values of the ratio.

$$\left|\frac{E_{0x}}{E_{0z}}\right| = \sqrt{\frac{q_0}{\sqrt{1+q^2}}}$$

(full curve) and of the angle of phase ϕ_0 (dotted curve).

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(*b*) For the conductor we have from equations (3) and (7)

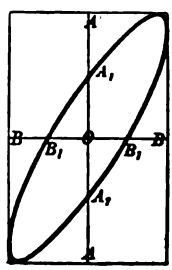
$$\frac{E_x}{E_z} = -\frac{r}{s} = -\sqrt{\frac{\iota(1+\iota q)}{q_0}} = -\sqrt{\frac{\sqrt{1+q^2}}{q_0}}.e^{-\iota\phi},$$

$$\tan 2\phi = -\frac{1}{q},$$

(2 ϕ in the 2nd quadrant),

i. e. $\phi = 90^0 - \phi_0$,

Since $\left|\frac{E_x}{E_z}\right| = \frac{1}{\left|\frac{E_{0x}}{E_{0z}}\right|}$,



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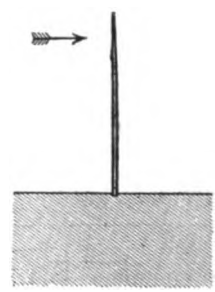

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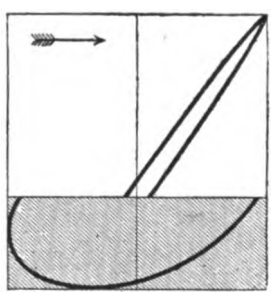

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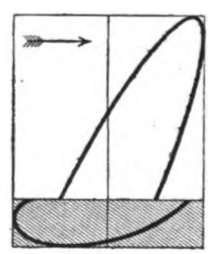

6

we can from the curves of Fig. 2 also obtain the corresponding values for the conductor.

If we desire to use the curves for other frequencies, it may be observed that the quantities q and q_0 only contain the ratio $\frac{\nu}{\sigma}$, and that consequently an increase or decrease of the frequency acts as a decrease or increase of the conductivity. Looking at the curves in Fig. 2 we see that neither in the air nor in the conductor is there a pure alternating field. The resultant electric field may be represented by a vector whose extremities during a period move in an ellipse (Fig. 3), the ellipse being such that—

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$$\frac{OB}{OA} = \frac{|E_x|}{E_z},$$
$$\frac{OA_1}{OA} = \frac{OB_1}{OB} = \sin\phi.$$

The most interesting cases in practice are the following:

1. $\frac{|E_x|}{|E_z|}$ small compared with 1 (Fig. 4).

The electric field, in the air and in the conductor, is, practically speaking, a pure alternating field. The lines of force are nearly perpendicular in the air and nearly parallel to the conducting surface in the conductor. From Fig. 2 it may be seen that this case is realised if the conductor possesses a conductivity which is not much less than 10^{-12} or 10^{-13} C.G.S. units. The dielectric constant of the conductor is in this case negligible.

2. $\frac{|E_x|}{|E_z|}$ not very small, the angle of phase ϕ_0 very small (Fig. 5).

In air the field is alternating, and its direction makes a considerable angle with the normal. On the other hand, in the conductor the field assumes a distinctly elliptic form. The curves in Fig. 2 show that this case occurs when the values of the dielectric constant are small; the lower the conductivity the more marked is this effect.

3. $\frac{|E_x|}{|E_z|}$ and the angle of phase ϕ_0 both considerable (Fig. 6).

The field in air is elliptical. The conditions in this case are that the dielectric constant be small and the conductivity σ about 10^{-15} C.G.S. for the frequency assumed above.

(To be continued.)

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INSTITUTION NOTES.

PROCEEDINGS OF THE COUNCIL.

MEETINGS of the Council were held at Buxton on April 1st and 2nd, 1908, and in London on April 11th and 13th, 1908, under the chairmanship of Mr. J. W. Woods.

The following notes of general interest to members of the Institution have been extracted.

The proposal to establish a Heaquarters and Reading Room in London has been carefully considered by the Council, but it was decided to postpone further action, pending the settlement of certain outstanding questions affecting the finances of the Institution.

The Council have pleasure in stating that a section of "corresponding members" has been formed, to which officers of Colonial and Foreign Administrations will be admitted.

The necessary steps have been taken to secure an alteration to the rules of the Institution, and it is anticipated that our colleagues will welcome the opportunity to share in the privileges of membership.

Full details of the scheme may be obtained on application to the Secretary of the Institution (see p. xv).

The routine work connected with the Institution has grown to such an extent that it has been essential to provide the Secretary with some relief. The Council have arranged to appoint a Librarian, who will act as Secretary to the Library Committee, and whose duties will include the control and distribution to members of books, periodicals, and printed papers.

The question of revising the arrangements, as regards circulation of technical periodicals, is receiving the earnest attention of the Council, and a circular on the subject will be issued to members at an early date.

ANNUAL REPORT.

The following short extracts have been taken from the report of The Second Annua Meeting of the Institution which was held at the St. Bride Foundation Institute, Bride Lane, E.C., on Monday, April 13th, 1908.

The chair was taken by the President, Major W. A. J. O'Meara, R.E., C.M.G., in the presence of the Officers and Council and about 100 members.

In presenting their report on the second year's working of the Institution of Post Office Electrical Engineers, the Council congratulated the members upon the progress which had been made in consolidating the results of the initial session

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MEMBERSHIP.

No. of members on roll during 1906-7	763
Deaths and retirements during 1906-7	8
No. of members on roll March 31st, 1907	755
Transfers to other Departments and names subsequently written off	7
Actual membership March 31st, 1907	748
Resignations taking effect April 1st, 1907	63
Actual membership April 1st, 1907	685
New members enrolled during 1907-8	83
	768
Deaths and retirements during 1907-8	13
Actual membership March 31st, 1908	755

As regards the distribution of the members, the following statement indicates the strength of each Centre on March 31st last year and on March 31st this year:—

CENTRE.	MARCH 31ST, 1907.	MARCH 31ST, 1908.
Metropolitan (including the Southern District of England)	360	351
Eastern	36	34
South Midland	42	43
North Midland	31	35
North Eastern	43	43
Northern	41	38
North Western	30	33
North Wales	45	53
South Wales	40	44
Scotland East	22	21
Scotland West	20	26
Ireland (North and South)	38	34
	748	755

The Council have deemed it desirable that there should exist some means whereby officers retiring from the Service may, at the discretion of the Council, be enabled to continue in touch with the Institution and its work. Sir John Gavey, C.B., and A. W. Heaviside, Esq., I.S.O., have accordingly been elected Honorary Members.

The Council have also had under consideration, at the suggestion of the President, the question of enabling officers of Colonial and Foreign Administrations, who are engaged in telegraph and telephone engineering work, to identify themselves in some way with the Institution; and, actuated by the desire to secure the widest interchange of ideas on all subjects of professional interest, they have arrived at the conclusion that both the members of the Institution and their *confrères* in other parts of the world would benefit by the provision of a suitable method of attaining the proposed object. They therefore recommend the establishment of two classes of "corresponding members," namely,

"Colonial corresponding members," at a subscription of half a guinea per annum, and—

"Foreign corresponding members," at a subscription of one guinea per annum.

The privileges of these members would consist in the receipt of a copy of each paper printed by the Institution, and of the 'POST OFFICE ELECTRICAL ENGINEERS' JOURNAL.'

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Institution Medals.

The Council have great pleasure in notifying that they have awarded the Institution Medals for the year 1906-1907 as follows:—

Senior Silver Medal: Mr. J. E. Taylor, for his paper on "Electric Wave Propagation."

Senior Bronze Medal: Mr. J. G. Hill, for his paper on "Telephone Transmission."

Junior Silver Medal: Mr. A. O. Gibbon, for his paper on "The Construction of Underground Telegraphs in the Provinces."

Junior Bronze Medal: Mr. J. S. Brown, for his paper on "Telephone Trunk Signal ling Arrangements."

The Library.

The Council have pleasure also in stating that, with the view to enhance the value of the Library, the Committee have concluded arrangements for the exchange of publications with the following scientific and learned societies, viz.:—

The Royal Institution.
The Physical Society of London.
The Institution of Mechanical Engineers.
The Institution of Electrical Engineers.
The American Institute of Electrical Engineers.
The Incorporated Association of Municipal and County Engineers.
The Institution of Junior Engineers.

The total number of books in the Lending Library is now 680, representing 474 separate works, the 206 extra copies of books in considerable demand being distributed among 92 separate works. The issues from the commencement now reach a total of 1400, the average period of loan being about twenty-five days. The demands have been distributed very evenly over the various sections, and only about 70 volumes have not yet been issued.

The experience gained during the earlier stages of the work of the Library Committee led them to the conclusion that the value of the Library to the members of the Institution would be greatly enhanced by the inclusion in the catalogue of a brief synopsis of the contents of each work, and accordingly it was decided to undertake the preparation of a new catalogue. This labour has been progressing gradually during the past winter, and it is hoped that before the opening of next session the new catalogue will be in the hands of the members.

Imperial College of Science and Technology.

In the course of the year, His Majesty the King granted a Charter for the formation of the "Imperial College of Science and Technology," and the Council, in pursuance of the objects of the Institution, took steps with the view of submitting a petition asking that the Institution should be allowed to nominate one Member of the Governing Body. The proposal was placed before the Secretary to the Post Office, who, owing to the short period which had elapsed since the formation of the Institution, was unable to give his support. In these circumstances the matter was allowed to drop; but it is the hope of the Council that, at a later date, the subject may be revived, and that the Institution may be successful in its efforts to establish its connection with the progress of technical education.

LOCAL CENTRE NOTES.

EASTERN CENTRE.

The second meeting of this Centre was held on March 30th, when two papers were read as follows:

"Notes on the Construction and Maintenance of a Small Power Pneumatic Installation." Mr. F. S. Parkinson.

"Engineering Economies." Mr. A. Evans.

Mr. Parkinson's papers detailed the result of recent experience obtained in connection

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with the laying of a pneumatic tube at Norwich, between the Head Post Office and the Market Place B.O. The paper was illustrated by a number of drawings and was full of explanations as to the methods adopted in overcoming difficulties which had arisen during the construction of the installation, methods which cannot be found in any text-books. One ingenious feature of the installation is the fitting of a starting switch which enables the motor and pump, situated in the basement, to be started from a remote point by means of an ordinary single-pole switch. An interesting discussion took place and much valuable detailed information was elicited.

The paper contributed by Mr. Evans was devoted to the processes of wire running. Mr. Evans has developed, it is believed, what is a new method of attempting to analyse the cost of the several ways of carrying out this work, and his analysis showed some striking differences due to the various methods which obtain. The discussion on this paper was unfortunately much curtailed owing to lack of time.

The concluding meeting of the Session was held on April 27th, when a very interesting paper was read by Mr. E. H. Shaughnessy on "Submarine Cable Laying and Repairing." The lecture, which was illustrated by some excellent lantern slides, described in detail the laying of a submarine cable between Galveston, Texas, and Coatzacoalcas, as well as the surveying of the Mexican Gulf from South of Vera Cruz, and also dealt with the picking up and repairing of a faulty cable about 100 miles from Galveston. The description of the method of deep-sea sounding and shallow water (up to 100 fathoms) sounding was particularly interesting.

During the discussion which followed, Mr. Jenkin mentioned that he had seen the process of laying shore ends on the east coast very many years ago, and stated that the methods now adopted presented no marked departure from those which were in use at that time.

Many details in connection with the laying, repairing, and buoying, etc., of cables were discussed, and also the methods employed for keeping test on a cable during the whole process of laying.

The chair was taken on each occasion by the President, Mr. J. Jenkin, and the meetings, which were exceedingly well attended, terminated with a hearty vote of thanks to the lecturers.

NORTHERN CENTRE.

The last meeting of the 1907–8 session was held on April 13th, when a paper was given by Mr. J. W. Graham on "The Rate Book."

The title of the lecture did not lead one to think that it would be particularly interesting, but in the hands of Mr. Graham, who is an expert in stores matters, it proved one of the most instructive of the session. The lecturer dealt with the rate-book in sections, and from each section took several items, and explained in detail their construction and uses

An interesting discussion followed, in which a large number of members took part.

A hearty vote of thanks was passed to the retiring Committee, particular reference being made to the Chairman, Vice-Chairman, and Secretary, to whose interest and energy the great improvement on the previous year's working was due.

The prospects for next session are very bright.

SCOTLAND, WEST CENTRE.

Four successful and well-attended meetings have been held during the past few months, at which papers of a very interesting and highly instructive character were read by the following gentlemen:

November, 1907.—"Telephone Transmission Efficiency." Mr. T. Hetherington.

February, 1908.—"Underground Construction." Mr. G. H. Comport.

March, 1908.—"Graphs: Some Examples of their Application in Connection with Works and Maintenance." Mr. A. S. Angwin, B.Sc.

April, 1908.—"Post Office Removals." Mr. J. Lockhart.

The encouraging remarks made at these assemblies by the Chairman, Mr. D. M. Stewart, and Vice-Chairman, Mr. W. McNair, relating to the utility and progress of the Institution, were much appreciated.

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NORTH-WESTERN CENTRE.

The last two meetings of the 1907–8 Session were held on Marth 4th and 30th, the following interesting papers being read :

March 4th.—" Notes on Brickwork and Road Construction." Mr. W. B. Smith.

March 30th.—" Wireless Telephony." Mr. R. Lawson.

METROPOLITAN CENTRE.

THE Metropolitan Centre Meetings of the coming session have been arranged to take place on the second Monday of each month, October to March inclusive, and the Annual Meeting of the Institution—which, by rule, is the last meeting of the Metropolitan Centre—on the third Monday in April, 1909. The programme of visits commences on September 7th, and will continue on the first Monday in each month. The series of visits will include the Stores Department (Central Depôt), Mount Pleasant and Holloway Factories, Messrs. Siemens Bros., the Robertson Lamp Works, Chelsea Power Station, and the Cable Ship " Monarch."

NORTH-EAST CENTRE.

The Local Committee are pleased to report that a position for the Reference Library has been found in the General Office. A list of the books authorised for the library has been prepared and will be distributed when the few outstanding volumes are received It is hoped that the more prominent display of the books will result in an extended use of the Library.

The last meeting of the 1907–8 Session was held on April 13th, when our genial representative from Bradford, Mr. Bailey, gave a most instructive paper on " The Transfer of the Bradford Trunk Exchange: Some difficulties and how they were met."

The subject was handled in a most entertaining way, and much valuable information not to be found in any text-book was obtained.

SOCIAL.

NORTHERN CENTRE.

A GOLF match between the Engineering and Surveyor's staffs was played on May 21st over the Town Moor course, when our men were severely beaten, Mr. A. Scott being the only player on our side to win his game.

Mr. Pullen's men are much elated over their success, but better luck may be ours next time.

The Royal and ancient game is not the only one that commands the attention of our staff. A Bowling Club has been formed and promises to be very successful. The Committee have already arranged a two bowl handicap and a rink competition, and there are more to follow.

A Swimming Club is also a future possibility.

NORTH-EAST CENTRE.

The Annual Cricket Match between the Clerical Staff and the Leeds Linemen took place at Roundhay Park on June 2nd, and resulted in a victory for the Clerks. On behalf of the latter, Mr. Whitfield's performance with the ball is worthy of special mention, 8 wickets falling—all clean bowled—at a cost of 7 runs.

CHESS CLUB NOTES.

METROPOLITAN CENTRE.

THE Annual Supper of the Chess Club was held at the Manchester Hotel, Aldersgate Street, on April 2nd. The President, Major O'Meara, was in the chair, and eighty-seven members and friends were present. The toast of " The Club " was proposed by Mr. G. Morgan (Controller of Stores), and the toast of " The Chairman " by Sir John Gavey,

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C.B. An excellent musical programme was presented, and, as on previous occasions, the function was a most enjoyable one.

The final match of the session took place at "Ye Mecca" on March 31st, when the 2nd Team beat the Controller of Stores' 2nd Team by $6\frac{1}{2}$ to $3\frac{1}{2}$

Mr. R. A. Wells won the Championship of the Club for the 1907–8 season with a score of $11\frac{1}{2}$ out of 14 games played, and the Handicap Tournament was won by Mr. W. D. Frewin.

VISITS TO MANUFACTURERS' WORKS, ETC.

SCOTLAND WEST CENTRE.

On April 16th, a visit was paid to Messrs. The Craigpark Electric Cable Company's Work, Springburn, Glasgow, manufacturers of Flameproof G. P. and Lead-covered Cables. The visitors were greatly interested in the processes of manufacture, which were minutely described by the Company's Officials.

NORTH-WESTERN CENTRE.

By the courtesy of Mr. Frederick Smith, the members of the North-Western Centre of the Institution paid a visit to Messrs. F. Smith & Co's. Wire Drawing Works, Salford, Manchester, on March 4th and 5th.

The greatest pains were taken by Messrs. Arthur Smith and W. H. Childs to explain the various processes, from the heating of the copper ingots to the finished wire. Everything proved of the greatest interest and extremely instructive, and the thanks of all concerned are due to the gentlemen above mentioned.

COLONIAL AND FOREIGN NOTES.

Contributions are invited from readers abroad.

CORRESPONDENCE.

To the Editors of THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL.

EDUCATIONAL QUALIFICATIONS.

I SHOULD like, if the exigencies of space in our new JOURNAL will permit, to submit to my fellow members of the Society of P.O. Engineers one or two impressions that seem to me to be worth emphasising in connection with the meeting of March 9th, when Sir John Gavey read his very welcome paper upon the "Training of a Telegraph Engineer."

Most of those who subsequently took part in the discussion gave expression to the feeling that we nearly always have when a high standard is set before us—it is too high for me. The feeling is perfectly natural—its expression needs cool judgment. In this instance the general impression conveyed was probably not that which the speakers intended. Every member doubtless recognises that the change in the qualifications possessed by the average engineer of to-day as compared with those possessed by the average engineer of, say, twenty years ago, is of a revolutionary character: the advance, to say the least, is remarkable. It is no disparagement of the work done by those older men to say that the continued development of the system compelled the creation of a new type of engineer. In the same spirit, it must be recognised by any judicial mind that the foremost position claimed for and largely admitted to be held by British telegraphy is due, not to those whom we ordinarily refer to (somewhat euphemistically, perhaps) as the older type of engineer, nor to us who to-day give the Department of our best, but rather this premier position has been earned by a select few (how few perhaps we hardly realise) whose work was that of pioneers, and from whom we have received this splendid position, which it is to be our privilege to maintain. Such men worked among their colleagues and were oftentimes not recognised as the giants they were; such men are working out their destiny in our midst to-day, whom, in the times to come when they shall have "arrived," we shall all feel sure that in the earlier days we recognised as "coming men." There is room and always will be room for the real genius to find his way to the top, unless, of course, he expects to be wafted there without the effort of climbing. All this

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leads to the real point that, for the average man, higher education is increasingly essential in the making of an engineer, and we shall be well advised if we learn to welcome the inevitable.

So far as the P.O. engineers are concerned there is a disturbing (although it might even be claimed as a steadying) factor—permanency of appointment. A commercial firm can afford to employ in a subordinate position a pushing, energetic man of very mediocre capacity, so long as he can do the work required, because as soon as he ceases to be able to meet the demands made upon him his services can be dispensed with, and a new up-to-date man brought in. In the P.O. Engineering Branch such conditions cannot rule. An engineering officer must, as far as can be estimated, be potentially capable of performing at a later time the duties of a comparatively high position, or he should not be given a permanent appointment. Otherwise, no matter how zealous he may be, lack of promotion will ultimately break his spirit; or should his usefulness lead to the condonation of his lack of ability he will find himself in a pitifully false position, and the *status* of his more highly endowed colleagues will suffer depreciation.

I fear I have already occupied too much space without touching upon what I look upon as a very important feature of the discussion—the Chairman's speech. Major O'Meara showed us that the educational and scientific demands being made upon the staff even now are behind those made by some other telegraph administrations, but on this point he is himself contributing a paper. I am not quite sure, however, that the true inwardness of another point of his speech was fully appreciated, and I think it very important for the promotion of good understanding that it should be made quite clear. The sidelight that he threw upon the claims being made was probably fresh to a large proportion of those to whom he spoke—it was to me, although I had quite recognised its probability. It was this, that while many of the staff have apparently felt that oppressive educational demands are being made by the new Engineer-in-Chief, he was able by a casual remark to show that he, as well as the late Chief, has been and is contending with the Civil Service Commissioners to secure the most favourable conditions possible for the present staff. It is not often that a Chief is in a position to let his subordinates see so far behind the scenes, and it may well be hoped that this little incident will tend to strengthen that feeling of good understanding and loyalty to the head of the Branch which is so important to the well-being of the whole staff. If our Institute or our Magazine wants a motto, let it be "Each for All."

A. J. S.

ESTIMATING PROCESSES.

THERE are few officers who have had to deal with estimates for overground works, who, at some time or other, have not felt that there was room for very considerable improvement in the method of preparing them. Changes in the authorised method of compiling such estimates have not been frequent. The most sweeping reform that has ever been effected was that which took place in 1907, when the Department authorised the adoption of the present system by which the minor stores are assembled into groups instead of being shown separately. The relief afforded by the alteration is very considerable, so far as the Superintending Engineer is concerned, but it affects the Sectional Engineer hardly at all. The latter has still under the new arrangement to make his survey, although not quite so minutely, prepare his summary of stores, and then classify them. This classification necessitates only a fraction of the entries in the estimate which were involved by the previous process, and, as he has a certain amount of latitude given to him in his choice of smaller stores, he is able to prepare the required details somewhat more readily than under the old system. He has, however, still to submit full details of the stores required on his requisitions. The Superintending Engineer, who is responsible for the checking, pricing, and preparation of the estimates for headquarters, has his detail work reduced to about one half of what it was formerly.

A suggestion has been received from Mr. Hook, Estimates Engineer at Nottingham, to the effect that the system of classifying stores should be still further extended, so that an Engineer may be able to requisition minor stores on a mileage or similar basis instead of having to show them in detail as at present. He contends that the scheme of classifi-

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cation is only half applied, and that by the adoption of his suggestion relief would be given to the officer most in need of it. A copy of Mr. Hook's proposal has been circulated to all the Estimates Engineers in the Kingdom, and the expressions of their opinions have been invited. These opinions have been summarised, and while the advantages, such as the saving in clerical labour, and freedom from delay owing to the non-arrival of small items of stores are recognised, it is thought that the disadvantages somewhat outweigh them. The principal objections urged are—(*a*) There is no provision for the frequent variation in the class of small stores required (*e.g.* various kinds of insulators, spindles, bolts, etc.); (*b*) higher freight charges would be incurred owing to the railway companies charging all stores in mixed parcels at the higher rates: (*c*) stores which are at present received direct from contractors would have to pass through a stores depôt; (*d*) such a system would not be suitable from an auditing point of view, as unnecessary unpacking and repacking would be involved.

One objection which several of our correspondents raised does not hold good. They contended that, owing to the variation in the number of poles per mile on open lines, different groups of stores would have to be provided to meet the varying conditions, or excesses and deficiencies would be met with. Such variations in the number of poles can readily be provided for by increasing or decreasing the number of miles on which the subsidiary stores required are calculated, *e.g.* if the average number of poles per mile provided for in the standard lists was thirty, and small stores for a ten-mile stretch of thirty-three poles to the mile were required then the quantity of subsidiary stores asked for should be

$$\frac{\text{Actual number of poles per mile} \times \text{total mileage}}{\text{Average number of poles}} = \frac{33 \times 10}{30} = 11 \text{ miles.}$$

The objection raised to the absence of flexibility which would result from the stores being assembled in the manner suggested is a serious one. It would obviously be impracticable to assemble subsidiary stores covering all types of bolts, insulators, spindles, etc., and all such cases which were out of the ordinary would involve separate requisitions.

The other objections do not require special reference.

It is doubtful if construction work would improve under such a system, as there would frequently be cases where stores had been received which were not quite proper for the work, but which could "at a pinch" be made to do; and as it would be simpler to use them than wait while others were supplied, it is probable that in many cases they would be used.

The Estimates Engineer at Cardiff, Mr. W. Scott, suggests the following alternative scheme:—"Taking it for granted the Engineers must make up a detailed estimate let it come into the District Office, and be copied on the Stores Sheet in detail as heretofore, but priced on the new mileage basis. When authorised, the Engineer should simply requisition 'Stores, as per W.O.————to be despatched to————,' or 'Stores, as per W.O.————with following departures, to be despatched to————.' This would include the apparatus requirements also. In the case of an estimate covering a long length of line needing stores to be delivered at more than one station, the estimate could be made up sectionally, as now done by many Engineers, if not all on one form, each section bearing a distinctive letter commencing at 'A' the requisition would then be made out, 'Stores as per W.O.————"A" to————"B" to————,' and so on. It would be desirable to re-arrange the estimate form which is now made out in the most useful style to meet all requirements. The Delivery Notes would be compared with the estimate instead of as now with the requisitions. The detail requisitions would have to be prepared in the District Office, where the clerical labour would be slightly increased in copying the estimate under the mileage system, but I believe relief would be given to the Engineer who needs it most."

This proposal has its advantages and the Engineer stands out as being something more than an automatic recipient of anything the Stores Department like to send, as he has the demanding of each individual item of stores that he considers should be used.

The making out of requisitions is, after all, not one of the highest duties and while

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any unnecessary work should be avoided standardisation can be carried too far. Some time ago a suggestion was made to Head Office to adopt an entirely different system of estimating. The delay which takes place between the preparation of the preliminary and the working estimates is frequently a serious matter. It was therefore suggested that as it was found that preliminary estimates prepared in the Superintending Engineer's office were on an average within 5 per cent. of the actual cost of works that (in view of the fact that the Superintending Engineer is permitted to depart from his Works Estimate without authority within a range of 10 per cent.) the so-called Works Estimate was an unnecessary refinement and could be dispensed with. The procedure in such a case would be as follows: On receipt of a "request for estimate" form from Headquarters the Superintending Engineer would ask the Sectional Engineer to report what, if any, strengthening, new arms, or line alteration would be needed on the lines concerned. Such information the Sectional Engineer can readily obtain; frequently without leaving his office. The Superintending Engineer, on receipt of these details, would price them at standard rates, submit estimates to Headquarters and receive authority. When this was received, details similar to those supplied to the Engineer-in-Chief would be sent to the Sectional Engineer. The latter would then make his survey on the lines laid down on the estimate and submit requisitions of the stores required. The requisitions would be scrutinised in the Superintending Engineer's office so that it could be seen whether the class of stores asked for was proper to the kind of work in hand and if correct they would, after being entered on a Stores Sheet, be passed forward for execution. The whole estimate would be viewed from a money standpoint, and when the authorised amount had been passed through the accounts it would be assumed that the work was finished and the Engineer would be asked to report completion. On the completion of the work, if everything was in order, the W.O. would close automatically and best feature of it all, as there would be no detailed estimate there could be no departures from it and consequently no explanations of departures. It is also contended that the system would ensure economy in the use of stores as there would not be any tendency to use them "lavishly" to prevent excess credits on the order and consequent explanations.

The proposal was considered by experts in Engineering Accounts and Auditing, and was said to satisfy all requirements.

It was also considered by the Superintending Engineer's committee, but as the present system had only just been introduced it was decided that until a more extended trial had been made of it a change would not be justified.

There is still plenty of room for reform and suggestions such as those of Messrs. Hook and Scott will I am sure be welcomed in the JOURNAL.

H. BROWN.

STUDENTS' SECTION.

IN this section, so far as space allows, answers will be given to any questions of general interest from an educational point of view. Queries should be addressed to the MANAGING EDITOR.

CITY AND GUILDS TELEPHONY EXAMINATION. HONOURS GRADE, 1907.

QUESTION 11.—A telephone underground circuit 20 miles long has the following constants:

Resistance: 88 ohms per mile loop.

Capacity: 0·07 m.f. per mile (wire to wire).

Assume inductance and leakance negligible, and that speech waves have an average frequency of 800 alternations.

What will be the attenuation constant and what percentage of current will reach the distant end?

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Answer.—The attenuation constant β of any telephone loop is given by the formula—

$$\beta = \sqrt{\tfrac{1}{2}\sqrt{(r^2 + p^2l^2)(s^2 + p^2c^2)} + \tfrac{1}{2}(rs - lcp^2)}.$$

where—r = resistance in ohms per mile of loop.

,, $p = 2\pi$ times the frequency of speech waves.

,, l = inductance per mile of loop in henrys.

,, s = leakance = $\dfrac{1}{\text{insulation resistance in } \Omega\text{'s}}$ per mile of loop.

,, c = capacity per mile (wire to wire) in farads.

If the inductance and leakance be negligible the formula is capable of great simplification, for $l = o$ and $s = o$, and

$$\beta = \sqrt{\tfrac{1}{2}\sqrt{(r^2 + o)(o + p^2c^2)} + \tfrac{1}{2}(o - o)}.$$

$$= \sqrt{\tfrac{1}{2}\sqrt{p^2c^2r^2}}$$

$$= \sqrt{\frac{pcr}{2}}$$

Inserting the values given :—

$$\beta = \sqrt{\tfrac{1}{2} \times 2\pi \times 800 \times 0{\cdot}07 \times 10^{-6} \times 88}$$

$$= \sqrt{\tfrac{1}{2} \times 2 \times \frac{11 \times 2}{7} \times 8 \times 100 \times \frac{7}{100} \times 10^{-6} \times 11 \times 8}$$

Cancelling out, this becomes :—

$$= \sqrt{2 \times (11)^2 \times (8)^2 \times (10^{-3})^2}$$

$$= 0{\cdot}088\sqrt{2}$$

$$= 0{\cdot}124 = \text{attenuation factor.}$$

If an alternating current of unit strength be impressed upon a circuit at the transmitting end, the strength at any distance d in miles from such end is given by the expression $e^{-\beta d}$ where e is the base of the Naperian or natural system of logarithms and equals 2·718 approximately. β is the attenuation factor above mentioned. If i be the current strength at distance d then—

$$i = e^{-\beta d}$$

$$= e^{-0{\cdot}124 \times 20}$$

$$= \frac{1}{e^{2{\cdot}48}}.$$

This may be evaluated direct by the aid of a table of natural logarithms or by conversion to the base 10 as follows :—

$$e = \frac{1}{10^{0{\cdot}4343}}$$

$$\therefore i = \frac{1}{10^{0{\cdot}4343} \times 2{\cdot}48} = \frac{1}{10^{1{\cdot}077}},$$

which, by inspection is rather less than one tenth. More accurately, by logarithmic calculation it is found to be $\frac{1}{11{\cdot}9}$ of the current at the transmitting end, or $\frac{100}{11{\cdot}9} = 8{\cdot}4$ per cent.

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STAFF CHANGES.

NOTE.—It should be clearly understood that these lists are unofficial; but every effort is made to render them accurate and complete.

BRITISH POST OFFICE.*

ENGINEERING DEPARTMENT.

PROMOTIONS.

Name.	Appointment.	Previous Service.
L. S. Connell	Asst. Submarine Super.	S.C. & T., Dundee, 1883; Tel., Edinburgh, 1883; Jr. Clk., E.-in-C.O., 1885; Sub-Engr., 1890; Engr., 2nd Cl., 1897; 1st Cl., 1905.
C. G. Roach	Engr., 1st Cl.	S.C. & T., Gloucester, 1886; Tel., C.T.O., 1891; Sub. Engr., 1897; Engr., 2nd Cl., 1900.
J. R. Matthews	Engr., 1st Cl.	Engr., 2nd Cl., 1902.
T. Adams	Senior Clerk (Prov.)	Tel., Liverpool, 1889; Jr Clk., E.-in-C.O., 1899.
S.W. J. Crawford	Senior Clerk (Prov.)	Tel., Glasgow, 1890; S.C. & T., Rothesay, 1892; Jr. Clk. E.-in-C.O., 1900.

RETIREMENT.

W. E. Hitch	Engr., 2nd Cl.	Tel., C.T.O., 1883; S.C. & T., Great Yarmouth, 1888; Relay Clk., E.-in-C.'s office, 1892; Engr., 1896.

DEATHS.

T. W. Lapham	Suptg. Engr.	Roy. Engrs.; P.O., 1883; Tel., C.T.O., 1885; Insp. Eng. Dept., 1885; Engr., 1st Cl., 1891; Asst. 'Suptg. Engr., 1897; Staff Engr, 1st Cl., 1905; Suptg. Engr., 1907.
C. J. Hall	Asst. Submarine Super. (Dover)	Navigating Offr., "Monarch," 1883; Insp., 1891; Engr., 1st Class, 1899; Asst. Submarine Super., 1905.

ABBREVIATIONS.

Asst., Assistant; C.C. & T., Counter Clerk and Telegraphist; Ch., Chief; Cl., Class; Clk., Clerk; Cont., Controller; Div., Division; Engr., Engineer; Exr., Examiner; Gr., Grade; Hd., Head; Hr., Higher; Insp., Inspector; Jr., Junior; Lr., Lower; Offr., Officer; Over., Overseer; P., Postal; Pn., Postman; Prin., Principal; Prob., Probationary; Prov., Provinces; Sec., Secretary; Sen., Senior; S.C. & T., Sorting Clerk and Telegraphist; Sr., Sorter; Stg., Sorting; Sta., Stationary; Supply., Supplementary; Sur., Surveyor; Super., Superintendent or Supervisor; Tech., Technical; Tel., Telegraphist; Temp., Temporary; Wtg., Writing.

Dist., District; E., East; I., Ireland; Met., Metropolitan; M., Midland; N., North; Scot., Scotland; S., South; Wa., Wales; W., West.

* It is hoped to include similar information from Colonial Administrations in future issues.

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OBITUARY.

Thomas William Lapham.

Universal sympathy has been aroused throughout the Engineering Department by the untimely death of Mr. T. W. Lapham, the recently appointed Superintending Engineer of the East Scotland District. The occurrence is rendered the more regrettable by reason of the very limited period which has intervened since he assumed office at Edinburgh in November of last year.

Mr. Lapham commenced his telegraphic career as a boy telegraph clerk in the corps of Royal Engineers in 1862. Four years later he was one of a group of twelve selected for service in Persia, where he took an active part in the erection between Bushire and Teheran of the pioneer telegraph line connecting Europe with India, for which, in conjunction with other Royal Engineer colleagues, he was accorded the commendation of the Indian Government.

He returned to England in 1878, and continued his military service in the Southern District as Inspector in charge of the Post Office Telegraphs at Exeter, Bristol, and New Cross, at which latter place he completed his service with the 2nd Division of the Telegraph Battalion, Royal Engineers, as Company Sergeant-Major in 1883. Immediately afterwards he was temporarily attached to the Head Office Staff of the Engineer-in-Chief, and engaged at the Gloucester Road Factory in the examination of apparatus in connection with the introduction of sixpenny telegrams.

In 1885 he was established on the permanent staff of the Post Office in the rank of Second Class Inspector. In that capacity he took charge of the Leicester Section of the North Midland District, where within ten years he had passed through the grade of First Class Inspector, and been promoted to the position of Assistant Superintending Engineer. Transferred to London only four years ago he successively occupied the positions of Assistant Superintending Engineer in the Central Metropolitan District, and First Class Staff Engineer at Headquarters.

His uniformly courteous and genial disposition, and the readiness with which he afforded his colleagues and subordinates the benefit of his extensive and varied experience, speedily secured for him universal high esteem.

The large and influential body of officials who attended his funeral at Morningside Cemetery, Edinburgh, on April 29th last, afforded eloquent testimony to the appreciation of his sterling qualities by his newly-found colleagues and friends in that city. His death, occurring, as it did, just when he had attained a position which it had been his ambition to secure, and to which his long and varied service in many climes so well fitted and entitled him, has evoked widespread and sincere regret. W. B.

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Henry Pomeroy.

Since our last issue it is our melancholy duty to record the somewhat sudden demise of Mr. Henry Pomeroy, late Superintending Engineer of the Midland Ireland District, which took place at his residence, Dollymount, Dublin.

Mr. Pomeroy retired under the maximum age limit clause in 1906, when he was made the recipient of a handsome presentation of plate from his many friends and colleagues in the Department, and it is with deep regret that the announcement of his decease has to be made within such a short period of that event.

For over forty-five years Mr. Pomeroy, although a Wiltshireman, was a well-known figure in Post Office and railway circles in Ireland, and by his charm of manner and genial good nature had endeared himself to a host of friends throughout the districts visited in the course of his official duties.

Mr. Pomeroy joined the Electric and International Telegraph Co., under Messrs. Culley, in 1858, after putting in a few years' service in the telegraph department of the Great Western Railway under Mr. Spagnoletti; was for some time in the Government Telegraph Office, Amsterdam, and joined the Engineering Department of the above-mentioned company in Dublin in 1862, since which his entire service has been spent in Ireland. He was transferred to the Post Office in 1870 and appointed superintending engineer of the southern district with headquarters at Cork in 1878, on the death of the late Mr. T. H. Sanger, the last to hold the old title of Divisional Engineer. Mr. Pomeroy continued at Cork until transferred to Dublin in 1901, where he continued until his superannuation in 1906.

In the early days of the telegraphs Mr. Pomeroy was regarded as a brilliant technical man, and took a deep interest in the introduction of the telephone, establishing in the early eighties single wire exchanges at Cork, Limerick, and Waterford, the subscribers' circuits being amongst the first erected by means of hard drawn copper wire. In recent years he was more specially interested in construction work, and in this connection always acted up to the belief that close personal supervision and inspection were better means of securing satisfactory work than the mere issuing of instructions.

Although a strict disciplinarian, Mr. Pomeroy possessed in a rare measure the full confidence of his staff that they could rely upon him to look after their interests, which tended in no small degree to the smooth working of the district in those days of strenuous labour in the Engineering Department. T. P.

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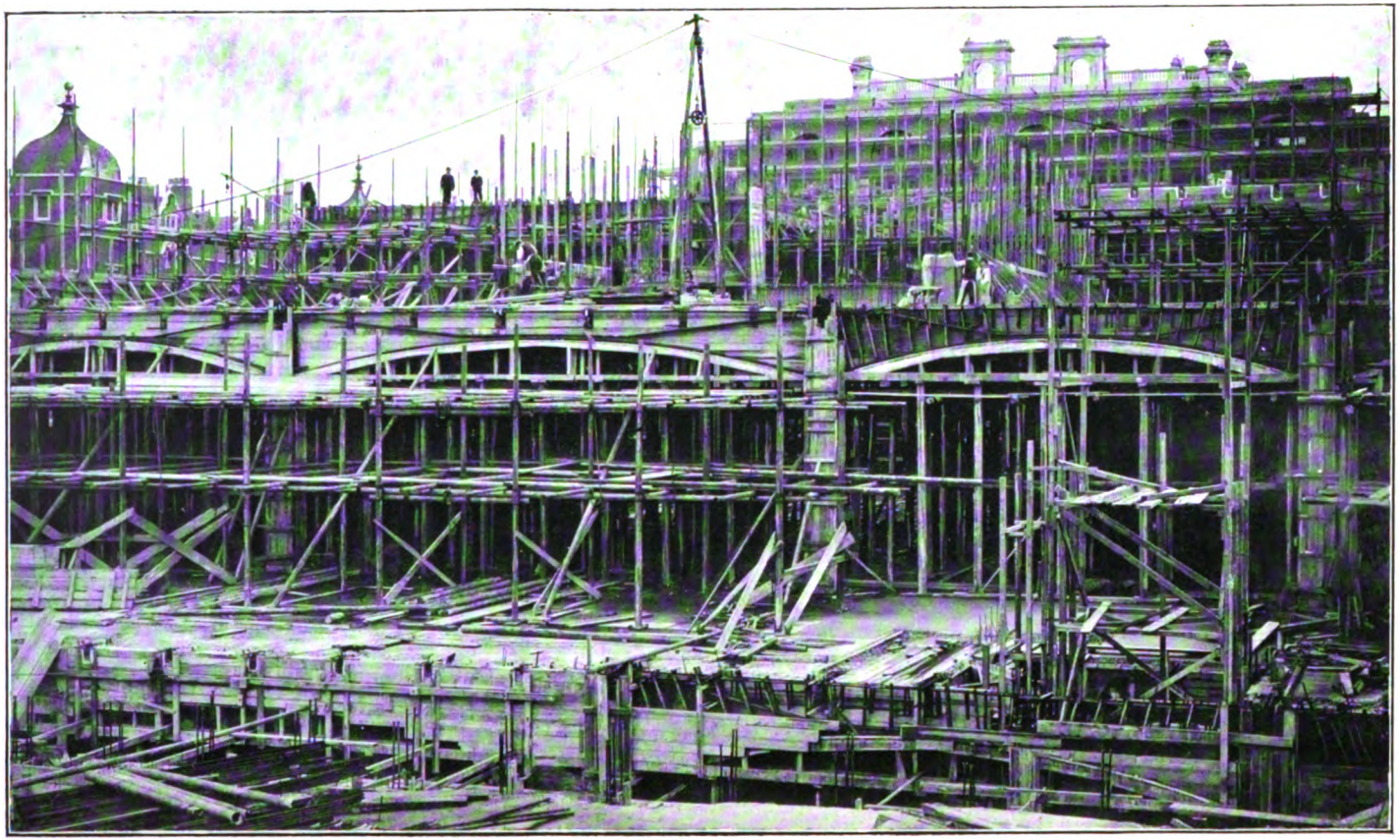

I.—View looking E., showing Beams in Ground and First Floors, with Roof of the G.P.O. (N) in the background.

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THE
Post Office Electrical Engineers' Journal.

THE NEW GENERAL POST OFFICE. (KING EDWARD'S BUILDING.)

By E. W. PETTIT.

THE following notes on the "King Edward's Building" now in course of erection may prove of interest to our readers, as the building itself undoubtedly is, to members of the public, many of whom stop to gaze on the unclothed skeleton rearing its head skywards with awe, mixed in some cases with not a little concern as to its safety.

The site is that previously occupied by Christ's Hospital, better known as the Bluecoat School, and is 156,800 square feet or just over 3½ acres in extent. The present building occupies roughly two thirds of this site, provision for extension being made at the west end. The foundation slabs are carried down to a depth of 31 feet, necessitating the excavation and removal of 128,000 cubic yards of earth, weighing upwards of 190,000 tons.

The strata of the ground was generally as follows: made ground, consisting mainly of foundations for the old Christ's Hospital building to a depth of 21 ft., 2 ft. 6 in. of loamy clay, 15 ft. 6 in. of ballast and river sand, and finally London clay. The foundation slabs go about 4 ft. into the ballast.

The river sand found in the ballast has, after screening, been used, resulting in a large saving in the cost of concrete.

A number of curios were found, Roman coins, pewter and old ware pots, etc.

Of interest also was the old Roman Wall, running right across the site, and now completely demolished. Its height was about 13 ft., width 8 ft. The foundations were of clay, covered with several layers of rough Kentish ragstones, then a course of sandstone blocks, a second series of roughly squared ragstones, a bonded layer three deep, of red tiles, a third course of ragstones, a second bonded layer of red tiles, and finally one or two layers of ragstones, the wall above this having evidently been removed when Christ's Hospital

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was built. The wall appeared to me to be in perfect condition, a tribute to the quality of the Romans' work.

In one spot several iron bars, used to bond the brickwork, were discovered. The iron had retained its original bloom and was quite free from rust. It is believed this work was carried out over 100 years ago, as part of the Christ's Hospital foundations. The condition of the iron bears out the argument of ferro-concrete advocates that these structures have an indefinite life.

The Contractors obtain current from the City of London Electric Light Co. at 400 volts D. C. for power and 200 volts D. C. for lighting. The woodworking machines, ballast screens, crushers, concrete mixers and hoists are all motor driven, and some 120 h.p. is used for this purpose. A number of arc and incandescent lamps are used for temporary lighting.

As is well known the form of the building is built up by means of timber centering and shuttering, the steel being placed in the moulds thus formed; the concrete is then poured in and rammed to prevent the formation of voids. It will be seen that the timber work must be sufficiently strong to take the whole weight of the steel and concrete until the latter has thoroughly set. Timbering may be removed after fourteen to thirty days, depending on weather conditions and the load on the structure; struts supporting the beams should be left for five to six weeks. In the case of walls, etc., carrying little or no load, shuttering may be removed after two days.

Although the timber is used several times, it is estimated that over 2,500 tons will be necessary.

The method of construction will be seen from the frontispiece, in which the construction of an arched beam is shown in four different stages. On the upper floor the steel skeletons are visible, and it will be noticed that the tension bars on the lower side of the beam are of two kinds: one pair follows the curve of the beam, the second pair being cranked, and rising to the upper side of the beam at the haunches. The compression bars along the upper face are straight; all the bars are carried for several feet into the next beam, and have fish-tail ends, to prevent their being drawn out of the concrete by excessive strains. The concrete web is reinforced by stirrups of flat steel passed over the bars, and in intimate contact with them. By these means the stresses on the lower bars are transmitted to the upper bars and the concrete.

It should be noticed how the bars and stirrups are distributed so as to resist the maximum bending stress in the centre, and the maximum shearing stress at each haunch of the beam, where the stirrups are much closer together; also that additional bars passing through each column are provided, to further increase resistance of the beams to shearing stresses.

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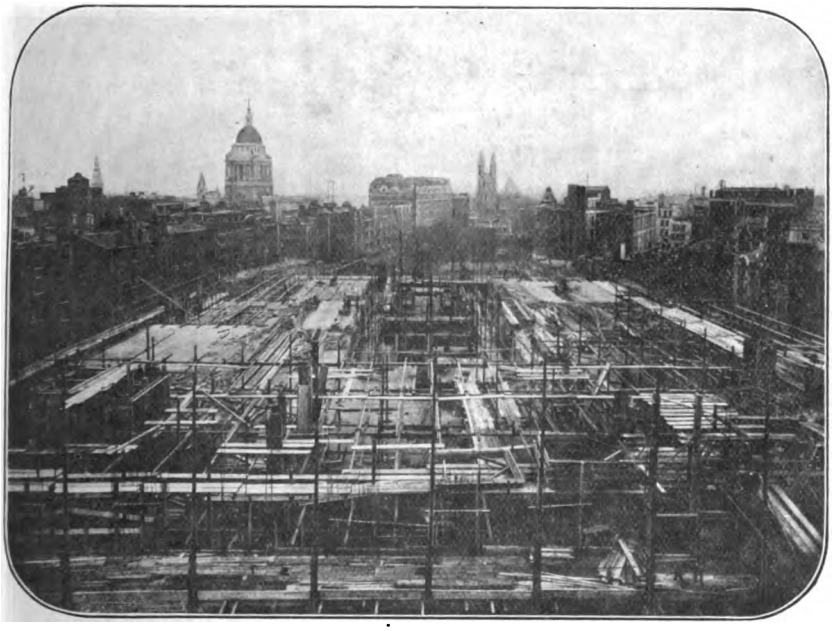
The steel is bent while cold by means of Jim Crows, but the fish-tail ends are opened when the metal is red hot. The two beams on the lower floor are in more advanced stages.

It is estimated that 3000 tons of steel of all sizes will be used, about one third of the weight necessary for a steel-framed building of the same size. Upwards of 21,000 cubic yards of concrete, weighing 31,500 tons, will be required, the whole being mixed by machinery.

The building will be absolutely fireproof; the fiercest fire would only destroy the internal fittings, leaving the structure practically



2.—View of Sorting Office Block from roof of Public Office Block, looking West.

unharmed. The concrete is impervious to moisture; there is thus no tendency for the steel to rust.

The effective area, and cubical contents of the building in ferro-concrete, are much greater than would have been the case in brick; for instance, the retaining wall is buttressed and 8 in. thick; in brick or plain concrete it would probably have been 4 ft. thick; the floors are 3½ in. thick against 8 in. of the ordinary floor.

The cost of ferro-concrete for large buildings is less than that of brick.

Some figures as to the size of the building will help readers to form an idea of the spacious premises which the London Postal Service Department will occupy on completion of the work.

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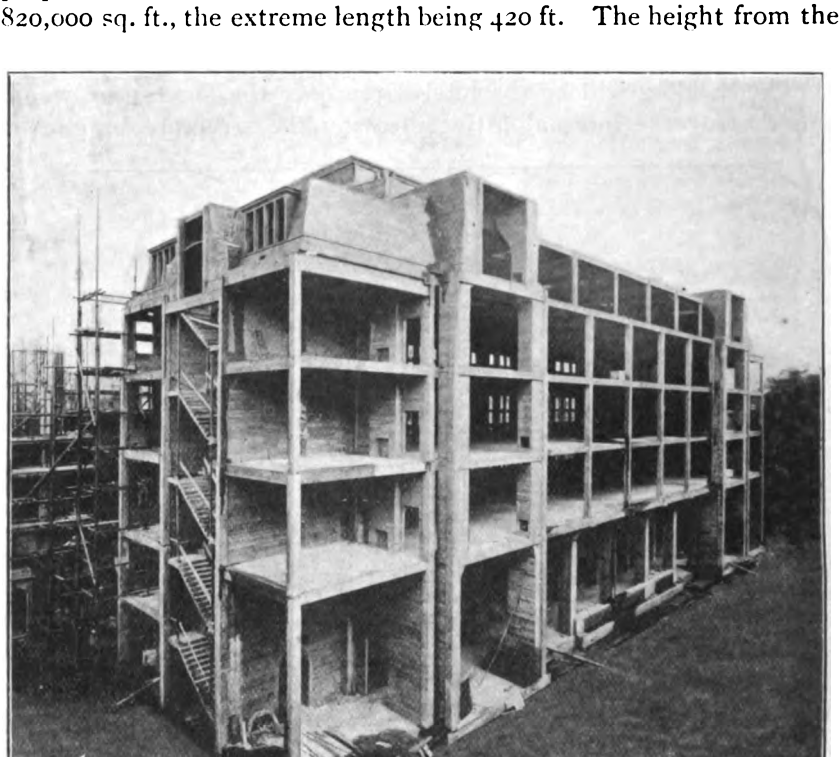
There are two floors below the ground—subground and basement—the basement floor being 25 ft. 6 in. below the pavement level.

The total length of the Sorting Office on the ground floor is 320 ft., the width of the west half 210 ft., that of the east half 180 ft., *i. e.* upwards of 625,000 sq. ft. between walls—a room of truly noble proportions. On the two lower floors the area between walls is 820,000 sq. ft., the extreme length being 420 ft. The height from the



3.—Public Office Block, looking W., showing Elevation to King Edward Street, in Readiness for Stone Front.

street level of the front building, known as the Public Office Block, is 84 ft., that of the building in the rear, known as the Sorting Office Block, is 76 ft.

The entire ground floor of the Public Office Block will be devoted to the Public Office, access being obtained at each end through entrance halls seen in photograph No. 1. The office itself is 150 ft. long, 50 ft. wide, and will have a finished height of 19 ft. 6 in.; the decorations are, I understand, to be of a very fine character. Each

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of the main beams carrying the upper floors contain 30 tons of concrete and steel. The four floors above will be used as offices for the executive staff of the London Postal Service; two lifts will be provided to serve these floors. The front and sides will be of stone on a granite base, the back of ferro-concrete. A feature of interest observable near the ground line at the front of the building is the provision for post-boxes. Letters and parcels will be dropped through the three huge openings and will fall on to travelling bands.

The sorting office is entirely of ferro-concrete, with the exception of the Newgate Street front 100 ft. in width, which will be of stone similar in design to that of the Public Office. The sub-ground, ground, first and second floors will be devoted entirely to dealing with the mails, the necessary storage space being afforded in the basement, while the retiring and dining rooms for the staff are located on the third floor.

Ten large lifts will be provided to facilitate the transference of the staff and correspondence from floor to floor, and in addition a number of mechanical conveyers, for distributing the mails from the large posting boxes in front of the public office, will be installed.

The building will be warmed and ventilated by means of a hot-water heating system; fresh air will be drawn in from behind the radiators, and the vitiated air extracted by means of large exhaust ducts and fans. The ventilating system will be applied to the lavatories also.

A plant to supply all necessary steam, a complete telephone system, and a high-pressure fire service fitted with the most recent appliances will also be installed. The current for lighting and power will be obtained from the Post Office power station.

It will be seen from these few notes that everything that modern engineering skill can devise is being used to equip the "King Edward's Building" for the purpose it is intended to fulfil, and I think that, when the building is completed, the British Post Office may congratulate itself on possessing one of the largest and best equipped sorting offices in the world.

The photographs showing the construction have been taken by the kind permission of Mr. R. J. Allison, chief assistant to Sir Henry Tanner.

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THE CULT OF THE CLERK.

THOREAU, who at no period of his life was a civil servant, has said that the mass of men lead lives of quiet desperation—what is called resignation being confirmed desperation. It is good to have this independent testimony that quiet desperation is by no means peculiar to civil servants, though by the very nature of things it is one of their characteristics and even one of their privileges. Unless the average clerk in a Government Department can see that any change which may be contemplated is in his interests he will, as a last resource, relapse into that quiet desperation of which Thoreau speaks, and this subject is approached with the hope that in at least one instance the feeling will be dispelled.

To hint at changes under such a title as this article bears may be to spread undue alarm, but when the germs of higher technical and commercial training infect a Department it would be folly to suppose that they will confine their attentions to the engineering officers in that Department and leave the clerical officers unscathed, unless, of course, it is taken for granted that the former class need their attentions more. Modesty, if nothing else, absolutely forbids us to take this view, and signs and indications are not wanting to show that before long those who, for various reasons, have considered it unnecessary to improve their knowledge of commercial subjects, may, in their own interests, deem it wise to do so.

The attainment of fluency in certain foreign languages and proficiency in such subjects as accountancy, commercial law and political economy is the desire, if not the ambition, of many clerks; but most of us, immediately after passing a keen competitive examination, have felt with Lowell, though from a different cause,

> "o'er us stealing
> The old familar, warm, champagny, brandy-punchy feeling,"

and so far as our books and studies are concerned we have cried, "*Jam satis, superque*," and have determined for the time being to abandon the strenuous life for such pleasures as are obtainable on a salary of £80 per annum.

That this feeling is very natural except in the case of the ubiquitous Scotchman will scarcely be disputed, but, as Locke has it, "When the mind has been once habituated to this lazy recumbency and satisfaction on the obvious surface of things, it is in danger to rest satisfied there." It is at this period that a sad mistake is often made and the acquisition of a knowledge of commercial subjects considered unnecessary or deferred until the spirit is no longer willing and it is too late to commence.

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The contrast with the behaviour of a clerk who enters an insurance office or commercial house is marked. His studies, instead of being on the point of completion, are only just commencing, because he knows that if he intends to make his way he must improve his acquaintance with foreign languages, pursue his studies in commercial law and kindred subjects, in short, learn anything and everything which by any conceivable chance may be of assistance to him. It may be argued that he will receive his reward and that his promotion will be rapid, whereas in a Government Department seniority must be taken into account. Granted that this is so to a certain extent, it surely cannot excuse a civil servant neglecting to obtain even a passing acquaintance with subjects which will undeniably assist him in his work, and render him not only a better servant to the State, but a more intelligent citizen.

In stating, therefore, that a clerk in a Government Department should follow the example of his brother officer in the commercial world, and proceeding to the logical conclusion that his proficiency in the subjects he studies may be tested by examination, we come to the vexed question whether the result of any examination can be regarded *inter alia* as a true test of efficiency? No better reply can be quoted than that given by Lord Macaulay when he replied to criticism concerning examinations in the Indian Civil Service: "Whatever be the languages," he says, "whatever be the sciences which it is in any age or country the fashion to teach, the persons who become the greatest proficients in those languages and those sciences will generally be the flower of the youth, the most acute, the most industrious, the most ambitious of honourable distinctions. If instead of learning Greek we learned the Cherokee the man who understood the Cherokee best, who made the most correct and melodious Cherokee verses, who comprehended most accurately the effect of the Cherokee particles, would generally be superior to a man who was destitute of these accomplishments."

Cherokee would be of little assistance to a clerk engaged on an intricate accounting duty unless perhaps it enabled him to give vent to his feelings in audible tones without fear of reprimand, but a knowledge of commercial systems of cost accounting might enable him to effect by representation a simplification of the system to which he is tied, and thus assist him to perform his duties to the greater satisfaction of his superior officers. One cannot thrive on one virtue, and it is certain that if the clerks of any Department determined to perfect their knowledge of up-to-date business methods they, as well as their Department, would materially benefit.

This duty, if it is acknowledged to be such, is not cheerfully and spontaneously undertaken by many unless there is associated with it a definite promise of reward. Unpalatable though the thought may

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be, it must be acknowledged that the hope of reward for the thing done is day by day becoming subordinate to the fear of displeasure and ostracism for the thing left undone. Let us explain.

Business methods are making rapid progress in Government Departments; red tape is becoming powerless before the onslaughts of card indexes, machine calculators, and girl-clerks; commercial methods of accounting are slowly but very surely being admitted; in a few years' time there will come under Government control an extensive business concern with its complement of business men, and at the transfer any remnants of the old order which may remain will have to fight for their existence with the new. It can be imagined what, then, will be the position of an officer who has been content to cry "*Jam satis*," and who is acquainted only with obsolete or obsolescent methods. To equip oneself with information over and above that required for the bare performance of one's daily duty must for these reasons be regarded first and foremost as one of the first principles of self-preservation, and secondly as instituting a claim for better conditions of service.

Experience shows that as a rule better conditions follow, and not precede a betterment of the intellectual fibre of a class. Ruskin tells us that that country is richest which nourishes the greatest number of noble and happy human beings, and the same may be said of any Government Department or commercial undertaking. It is recognised that the more prosperous the condition of any State or body the more flourishing is the condition of the units which go to compose it. Further, it is morally certain that the Department or Office which contains the Achilles, the Alexanders, and the Cæsars will thrive and be pre-eminent and the well-being of its employees will be materially improved.

Under such circumstances an incentive to study will, it is thought, be welcomed rather than ignored, and in future a question similar to that put by Lord Rosebery at Glasgow when he said, "What is the hall-mark which this University stamps upon its men?" may be asked of our Department and replied to with confidence. We may not all be able to reach the lofty pinnacle of knowledge where sate the village schoolmaster of whom it is said:

> "The village all declared how much he knew,
> 'Twas certain he could write and cipher too,
> Lands he could measure, terms and tides presage,
> And even the story ran that he could gauge."

But we can do our best.

T. B.

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LOCALISATION OF FAULTS ON UNDERGROUND CABLES.

By H. P. Brown.

It frequently happens during the construction of a main underground cable that modifications must be introduced in the ordinary form of Wheatstone-bridge testing before defects arising from various causes can be localised. On such cables it is essential that very accurate measurements should be possible, otherwise the cost incurred in removing a fault may be excessive. This paper is intended to suggest the nature of certain modifications which may be found useful.

It is perhaps safe to say that the two classes of fault which are most troublesome to deal with are high-resistance earths, especially if intermittent, and disconnections.

A high-resistance earth fault, sometimes showing several megohms with a normal voltage, is usually the result of one of three things, viz.:

(1) Small metallic particles find their way into the cable and get between the screening tape of screened conductors and the wire itself, or between the wire of unscreened conductors and the lead sheath, and ultimately pierce the insulation paper.

(2) The burr on the edge of a screening tape where the spiral tension is excessive, pierces the insulation paper.

(3) A projection on the wire itself, either at a manufacturer's joint or at an ordinary cable joint, pierces the insulation paper.

A defect of this nature in an actual cable length may not be revealed during the factory tests, but may develop while the cable is being drawn in and jointed.

For localising a high-resistance earth the ordinary loop method is used, but in place of a battery consisting of a few cells, a high voltage is applied. A convenient source is the generator of a 500 volt "Megger," which form of insulation testing instrument is now used almost universally. By this means, and by using an ordinary horizontal D'Arsonval galvanometer, having a sensitivity such that one millivolt gives a deflection of fifteen divisions, faults have been localised with considerable accuracy. The high voltage breaks down the fault and the resistance remains during the application of the voltage at a comparatively low value, while the output of the generator is insufficient to cause damage to the bridge.

The general principle of the test is perhaps almost too well known to need comment, but for the sake of convenience it is indicated in 1.

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If R = res. in ratio arm
R_1 = ,, ,, bridge, or adjustable rheostat arm
L = ,, of half-loop in ohms or represents length of half-loop in yards if both wires have equal res.

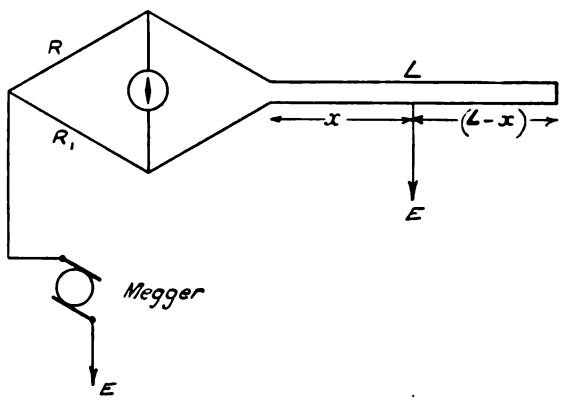
Then $\frac{R}{R_1} = \frac{L + L - x}{x}$

i.e. $x = \frac{2LR_1}{R + R_1}$.

It is, of course, advisable to make a number of measurements from both ends of the cable, and it simplifies matters, at any rate in the final test, to insert values for L in yards and not ohms. Then the distance of the fault is given direct in yards.

Disconnection.—The localisation of a disconnection would be a comparatively simple matter if a reflecting galvanometer, a Rymer-

1.



Jones discharge key and standard condenser, were available, and if suitable accommodation for setting up such apparatus could be secured on the road, but the method is out of the range of every-day practice. The following arrangement has, however, met with much success in actual practice, and has given very accurate localisation tests. It is simple and does not require any special care in manipulation.

It is an adaptation of the Bridge method of measuring capacity, and has the great advantage in this class of work of being a null method. The ordinary horizontal galvanometer previously referred to can be used.

The theory of the test, which is particularly simple, is here illustrated (**2**).

No deflection would be obtained when $\frac{R}{R_1} = \frac{K}{K_1}$ and, therefore, when this condition obtains $K_1 = \frac{R_1 K}{R}$.

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In a direct measure of the capacity of a condenser, K would, of course, represent a standard condenser.

Assuming that the localisation test is to be made on a cable under construction the measurements should be made from the end of the completed section, and the following length of cable used as a standard of comparison. The essential feature of the test is to select wires in the length to be used as a standard, *i.e.* to take the place of "K" in **2**, similar in electrical characteristics to the faulty wire. Should the fault be on a screened wire a number of screened wires in the standard length are bunched until the capacity approaches the capacity of the defective wire between the testing point and the fault, and the final adjustments for no deflection may then be made by the Bridge resistances. If the faulty wire is not screened and is in twin formation, the corresponding class of wire in the standard

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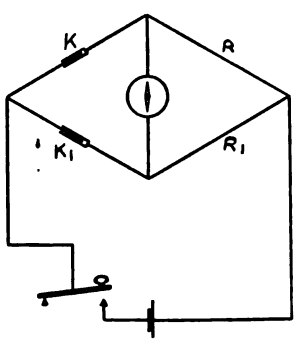

length should be looped at each end so as to obtain the required length, and one of the wires must then be earthed. In each of these cases the capacity of the standard will then be proportional to the number of lengths used. If, now, the length of standard cable is accurately measured in yards the actual distance of the fault is readily calculated from—

$$K_1 = \frac{R_1 K}{R}$$

where K and K_1 represent the lengths in yards corresponding to the capacities.

About 100 dry cells of small internal resistance should be available for this test. It is an advantage to vary the number of standard lengths and obtain a balance in each case by the Bridge resistance, finally taking the average of the results so obtained.

PROFESSIONAL PAPERS.

The attention of readers is called to the announcement on p. 2 of Supplement.

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CENTRAL TELEGRAPH OFFICE.

FOR some time engineering changes in the wiring arrangements of considerable magnitude have been taking place in the Central Telegraph Office, and now the cabling and general wiring is as well arranged as it can be, having regard to the fact that the General Post Office West Building is not particularly suitable for housing the largest Telegraph Office in the world.

The objects aimed at were, in the first place, to secure immunity from fire risks, and secondly, to facilitate and reduce the cost of changes in the positions of circuits, which the exigencies of the traffic in the C. T. O. appeared so frequently to demand.

In October, 1907, the final installation of the Metropolitan Inter-communication Switch was completed, and as a consequence of the amount of table space set free, and for other reasons affecting staff administration, a re-organisation of the Central Office was decided upon. The work, according to a return which the Controller prepared, involved the removal from one portion of the building to another of nearly fourteen thousand pieces of apparatus, and was accomplished without the slightest hitch or delay to traffic.

The circuits are now located as follows:-

Ground floor.—Switch Working Sets for Tube Office traffic and the Message Telegram Room.

First floor.—Telegraph School.

Second floor.—Cable Room—circuits working to South-South-East Offices, minor Midland and Northern Offices.

Third floor.—Main Provincial circuits, also Scotland, Ireland, and the Channel Isles. On this floor also are the News and Special Sections.

Fourth floor.—Metropolitan Inter-communication Switch, its working sets, direct circuits to certain Metropolitan Offices, and circuits working to the Home Counties.

Incidentally an increase in the number of Cord Telegraph Carriers, Concentrator Switches and a re-arrangement of the Pneumatic Tube System were contemplated, but these portions of the scheme are being proceeded with slowly.

Experiments are now being conducted with a view to determine the most suitable arrangement for working the pneumatic tubes automatically.

Two types of valve are being tried, one actuated by what may be termed a pneumatic relay, and the other being operated electrically.

Authority has been given for a trial of the Murray System to Berlin, the apparatus now in use at the C. T. O. on a Dublin circuit being utilised.

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Efforts have for some time been made by inventors to increase the speed of preparing slips for Wheatstone Automatic transmission.

It was, of course, at once realised that the typewriter principle was the correct one, and this has been adopted by all the inventors. The first system tried was the Creed, which used air for perforating.

Recently M. Kotyra, of Paris, devised an arrangement by which the pneumatic perforators in use in the C. T. O. were operated by three solenoidal electro-magnets placed over the valve pistons. A typewriter keyboard is employed, the depression of the keys bringing into action a motor-driven rack and pinion device which provides by means of a brush passing over horizontal segments for the completion of the electro-magnet circuits.

M. Kotyra has recently modified his apparatus, dispensing with the pneumatic perforator and operating a four-slip perforator directly by solenoidal electro-magnets of more powerful construction. He has also introduced a much improved form of keyboard.

The Gell two-slip keyboard perforator, which was originally tried in conjunction with a key-speed Wheatstone transmitter for sounder working, and a four-slip perforator of similar but stronger construction are also being tried experimentally in the News Division. In the Gell instruments each letter or figure is perforated by one operation, and in this respect the Gell differs from the Kotyra.

TAPPING ON TO KROONSTAD: A REMINISCENCE OF THE BOER WAR.

A STIFLING mid-summer's day towards the end of 1901 and the military operator of Holfontein Siding dozed on his blanket bed under the shelter of the regulation bell tent. Presently the faint call of the "buzzer" broke the stillness; //// //// //, //// //// //, it called. The message that followed instructed the operator to pack up his apparatus at once and report himself to Major H—, who commanded a fighting column camped close by. Major H— had obtained permission to include a telegraph operator amongst his supernumeraries, so Sapper 3456 found himself installed in a spare Cape cart, which had been allotted to him as a travelling telegraph office. Next morning he woke to find the camp astir, though it was still dark. Huge fires of broken waggons, *pianos*, carts, etc., blazed all round, and the cooks were busy preparing an early cup of coffee before starting. No time was lost in packing up, and the whole column was soon moving slowly over the veldt, before the sun had risen.

On the second day the Column came within sight of a telegraph

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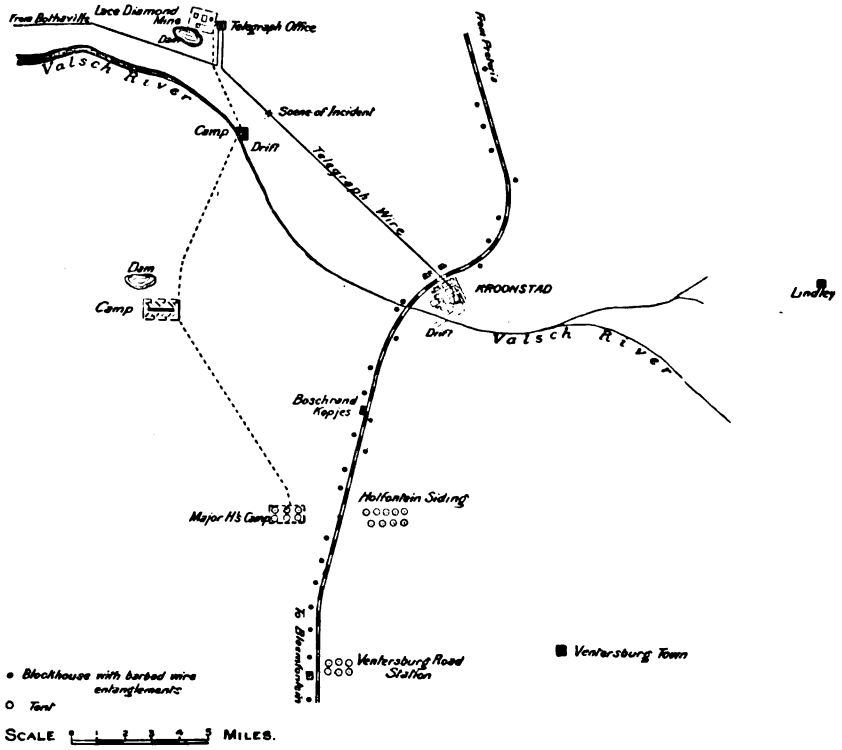
line, some two miles distant, and the order to pitch camp having been given, the operator drove off to tap the line and endeavour to get into communication with Kroonstad. The sapper was young and thirsted for glory, and on reaching the line he soon scaled an iron pole and teed a lead to the telegraph wire. After calling KDN for a time he got an answering signal, and an appointment was made to speak again at 7 p.m. The lead and instruments were left so that no delay might occur, and the operator drove back to the camp.

Major H—, when he heard of the proposed appointment, was



opposed to the idea, as several Boers had been seen on the neighbouring kopjes during the afternoon, but he at last consented.

A bundle of telegrams for despatch was handed to the operator, and, accompanied by a cavalryman who had lost his horse and had shared the Cape cart with him, he led his ponies along the "lines" in the direction of the telegraph wire. On reaching the outskirts of the camp the cavalryman proposed that he should visit the outpost groups who were on guard duty not far off, to warn them and to obtain the countersign. He had hardly gone when a light appeared in the direction where the instruments had been left, and the sapper's mind was perturbed as he thought of his apparatus being commandeered by brother Boer. It appeared a long time before his companion

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returned to tell him that the outposts had also been watching the mysterious light. The two young soldiers conversed in whispers as to a possible explanation. They hesitated as to whether they should advance or return to the camp. The light flashed once or twice and then disappeared altogether, so they decided to proceed. They drove on slowly, and each in turn descended from the cart at intervals, and lying flat on the ground scanned the dark outline of the horizon. Nothing more was seen of the light, yet both suspected that some Boers could not be far off. The horses appeared to scent danger, for they raised their ears as if listening to sounds which were not perceptible to the men. The soldiers knew they must come upon the line at some point, but it was necessary that they should reach the spot where the apparatus had been left.

It seemed hours before they found themselves under the line, and making for the nearest pole they descended to find no trace of instruments or tap lead. The Sapper slung his bandolier over his shoulder, and with loaded carbine in hand he followed the route of the line towards the right, examining the ground at each pole. It was the rainy season and the journey was not made easier by the swampy holes into which he sank knee deep, nor by the ant-hills over which he stumbled every few steps. After a fruitless search of half a mile he retraced his steps to learn that his companion had proceeded with the Cape cart in the opposite direction but without success. However, they determined to search further towards the left, and ultimately came upon the lost instruments all intact. A screen to shield the dim candlelight on three sides was soon improvised by means of an overcoat, and seated on the veldt with a battery box as a desk the operator called "/\/ /\/\/ /\" on his buzzer. He learnt then that it was nearly ten o'clock, almost three hours since they set out from camp. Messages were soon being despatched and all going well, when the ponies again showed signs of restlessness as if someone were approaching. The light was quickly extinguished and both men lay flat on the ground. Soon they heard the noise of mounted men and were surprised to see some twenty or thirty Boers ride past within a hundred yards of them. The ponies remained silent, in fear, and the khaki-clad soldiers were relieved to find that they were unobserved, and to see the cavalcade disappear again into the darkness. Five minute later the candle was lit again, and when the final message was received no time was lost in packing up and returning to the now slumbering camp. It was a wild drive. Ant-hills and deep holes were ignored, and the horses galloped without requiring encouragement or persuasion. The camp was reached in safety, and the two adventurers were congratulating themselves on their night's work when they found themselves unceremoniously pitched on the ground, along with instruments and provision tins.

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It was a three-foot ant-hill. Happily no bones were broken, and after replacing the Cape cart on its wheels again and collecting their property they drove more cautiously to the major's tent. Rousing him out of bed and delivering the despatches, the sapper and his companion unharnessed and tied up their ponies and went off to bed.

J. H. B.

THE HOLDING-POWER OF A SMALL WALL-BRACKET.

By JOHN H. M. WAKEFIELD.

IT was recently found necessary to make the following experiments to determine whether a bracket would be pulled out of a wall when a certain stress was applied in a line with the length of the bracket.

EXPERIMENT 1.—BRACKET IN CEMENT.

A small wall bracket fitted with an insulator and spindle was fixed in cement in a fairly old brick wall and left to set for a week. A 200 lbs. G.I. wire was then suspended from the insulator across a yard on a level, and in a line, with the length of the bracket. A stress was applied gradually by means of a tension ratchet at the other end of the wire, and the spindle took up a "set" at 400 lbs. The stress was increased to 550 lbs., but there was no sign of any outward movement of the bracket.

EXPERIMENT 2.—BRACKET WEDGED IN.

A similar bracket was hammered into the same wall and a wooden wedge fitted on each side of the bracket. Stress was applied as in Experiment 1, and a slight outward movement of the bracket was noted at 450 lbs. At 500 lbs. the movement was not appreciably increased.

EXPERIMENT 3.—SIMPLE DRIVE.

A similar bracket was driven straight into one of the vertical joints of the brickwork, neither cement nor wedges being used. At 500 lbs. the spindle took up a "set." At 550 lbs. no appreciable difference was noted, and the bracket did not seem to have taken any outward move.

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Experiment 4.—Point of Application of Stress Altered.

The conditions were the same as in the last experiment, except that the 200 lbs. G.I. wire was passed round the eye of the bracket, the insulator spindle being removed, thus altering the point of application of the load, as in the case of a "J" cupholder. A stress of 550 lbs. was registered, but no outward movement of the bracket could be observed.

Breaking and Working Stresses of Wires.

The minimum breaking stresses of the wires usually fixed to small brackets and the maximum stresses to which they should be subjected are as follows:

	Minimum breaking stress, lbs.	Maximum working stress, lbs.
40 lbs. bronze	197	66
100 ,, copper	330	80
70 ,, bronze	345	115
200 ,, G.I.	620	135
400 ,, ,,	1240	270

Conclusions.

In the case of Experiment 2 it is doubtful whether the same driving force was applied as in the other experiments, hence the lower reading.

It will be observed that the first "effect" was noted at 400 lbs., when the spindle took up a "set." As this stress is above the minimum breaking stress of the first three gauges of wire mentioned, the experiments would appear to show that in the case of 40 and 70 lbs. bronze and 100 lbs. copper wire the wire would break before the spindle took up a "set," and that in the case of the 200 and 400 lbs. G.I. wire the spindle would take up a "set" before the bracket showed signs of being pulled out.

It is therefore clear that if a small bracket is properly driven into a good wall there should be very little risk of it being pulled out if the above-mentioned classes of wire are used, even if the maximum working stress is applied.

Much depends upon the age and thickness of the wall, and whether the bricks are in mortar or cement. The use of cement to fix the bracket means a second visit to run the wire after the cement has set. It is therefore much cheaper to use the simple drive if the wall is a good one.

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REMINISCENCES OF OVERHEAD AND UNDERGROUND TELEGRAPH WORKS.

By G. W. Hook,

Superintending Engineer, South Midland District.

(*Continued from p.* 117.)

I very well remember the day when the first specimen of lead-covered cable was sent across to our offices at Mount Pleasant by the Chief (now Sir William Henry Preece). My late respected Superintending Engineer, Mr. Eaton, did not look upon it with any favour, and told me that if that was a specimen of what we had to handle in the future he was not sorry he was near his retirement.

This was the Fowler Waring four wire solid core cable, and being the officer in charge of the underground work of London at the time it fell to my lot to deal with it. We had to draw six of these into a line of pipes from T.S. to the Stock Exchange Office in connection with the London-Paris telephones. The route was *via* St. Paul's Churchyard, Cannon Street, and St. Swithin's Lane, and this being quite a new departure in underground work, I felt it incumbent on me to be with the men to supervise the work. All those who are acquainted with the City of London will recognise that the thoroughfares I have mentioned are very congested and busy in the daytime. I therefore decided to carry out the work at night-time, particularly as I intended to attempt to draw the six cables in at one time, which meant six drums occupying the footway. The first attempt was disastrous, the cables jamming. I then tried three at a time, but found that the cables twisted over each other in the pipes, and the same thing happened with two. We tried every means we could think of to keep the two cables in their proper position, but failed. We then determined to draw the cables in one at a time, and I borrowed some sweep's rods for the purpose from the City of London Electric Light Co. This proved satisfactory, and each cable kept its position throughout. This operation of pulling in lasted a week. I think it was the hardest week's work in my life, but the experience gained was valuable. I left home at 11 p.m., worked in the streets directing the men till 7 a.m., then went to an early coffee house for breakfast, after which I went to the office, had a wash, and attended to my ordinary duties until 4 p.m., when I went home and to bed.

This work was carried out in the latter part of June. The weather was splendid, and although I am a Londoner and have spent my life in London, with the exception of the last few years in Birming-

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ham, I never before imagined that London City was so beautiful and imposing as I saw it in the early hours of those few summer mornings, when I was out on the cable work. I took some provisions with me, and sat on the steps leading up to Cannon Street Railway Station one morning about 3.30 to eat a meal, and was struck with the beautiful azure-blue appearance of the atmosphere, and the dome of St. Paul's Cathedral looked magnificent through it. I have not visited Venice, but from what I have read I should think Venice atmosphere would be applicable to London as I then saw it. Presently the rising sun gilded the cross on St. Paul's dome, and then, as the sun rose higher, the azure blue disappeared, and as the fires in the offices, etc., were lighted, the smoke began to rise, and it was the usual old London once more. The next morning at 3.30 I walked down to Blackfriars Bridge and looked up the river. This is the time to see and appreciate that fine old river the Thames. All the buildings on each bank stood out in bold relief, there was that same beautiful blue tint in the air, and the rising sun was gilding the tops of the high buildings, including the Houses of Parliament, while the barges passed silently and slowly along with the tide.

It is quite true London never sleeps. Throughout the whole night there is traffic of some kind. Market carts loaded with vegetables, vans loaded with frozen meat being taken to and from the cold storage warehouses, and, in the early hours, the newspaper vans being rushed from the Press to the different railway stations with horses at full gallop, which I believe is allowed by the police authorities. Another thing which is very noticeable is the number of policemen to be seen about. It would appear as though there were more policemen on duty in the City at night than during the day protecting the valuable property. Cats also are very much in evidence. They all seem to congregate in the streets in the early hours, bent on courting, fighting, or stalking the pigeons.

I will relate here a strange incident which occurred when we were proceeding with the cabling in one of the City streets. It happened that a jointing chamber had been placed just in front of a fruiterer's shop. At about 2.0 a.m. we had the cabling plant and drum of cable drawn up at the shop, ready to proceed with the work, when a man appeared at a window immediately over the shop and ordered us to clear off or he would shoot us. I tried to reason with him, telling him that we should not be long with the work, but he would not be pacified, and with an oath, saying he would fetch his revolver, he disappeared into the room. We came to the conclusion that the man was a lunatic, so we all took to cover in shop doorways, etc., and a police sergeant appeared on the scene just as the man again returned to the window. I told the sergeant what

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had transpired, and he spoke to the man, telling him to go to bed and not make a fool of himself. It appeared that he was the proprietor of the shop, and on the morning that he had to go to market made it a practice not to go to bed, but to fill in the interval with sundry refreshers. After a little talk he closed the window, the sergeant of police departed, and the work proceeded. Suddenly the gas was lighted in the shop and the man appeared at the door and beckoned to me. I went to the door and he asked me if I was in charge of the work. I said "yes," and that we had almost finished, when he asked me to come inside as he wished to speak to me. I must confess that I did not accept the invitation with alacrity after what had transpired, but as there were no shutters to the shop windows or door, and everything could be observed from outside, I told my foreman to keep an eye on the movements of the man, but to push on with the cabling.

When I got inside, the man said it was too bad making such a noise outside his place, and what made it worse was that his wife had broken her leg that day and was lying in bed in great pain. I said I was exceedingly sorry, and that if he had told me that in the first instance I would have skipped the work in front of his shop. Just at that moment a female appeared at the door leading from the private rooms to the shop, and said, "Now then, when are you coming to bed."

I could see now that the man was a bit wrong in his head, so I wished him good morning, but he would not let me get away until I had sampled some of his special strawberries, and then some fine grapes and peaches. While this was going on the men had finished their work, and in order to give them time to clear away their plant I gave a further proof of my zeal for the Service by eating a few more very fine strawberries, and even then he would not let me come away without a basket of fruit, which he tied up neatly and carefully for me to take home to my wife. He then opened the door and shook hands, and I saw him turn out the gas and disappear through the private door. It was an extraordinary incident, but I must confess the fruit was very nice and refreshing at 2.30 a.m., and later my wife thoroughly enjoyed her share.

To return to the cable, it now became a question as to the jointing. There were no instructions, or past experience of anyone to guide me, therefore as a temporary arrangement, and to allow of the conductors being brought into immediate use for the Paris Telephones extension to the Stock Exchange, I purchased some I.R. hose piping, which was cut into convenient lengths as sleeves, and after the four wires in each cable were insulated and jointed, the sleeves were drawn over the joint and wired at each end. The Fowler Waring Company then tendered to make permanent joints and this was

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accepted. The method they adopted was to smear the bared core at the joints with a bituminous compound, which was melted and kept in a plastic state by means of a spirit lamp, and when worked down with the fingers sufficiently, the lead sleeve was drawn over the joint and fixed by a plumber's wipe. After some short time the insulation proved to be low, and I came to the conclusion that this had been brought about by the Company's men using a spirit lamp to melt the compound on the conductors. There is a certain amount of vapour in the flame of a spirit lamp which anyone can observe by passing a piece of cooled silvered glass over such a flame, when the glass will be found to be covered with vapour. I assumed that the moisture had been bottled up in the joint and thus had brought down the insulation. I communicated my views to my superintending engineer and the Engineer-in-Chief, and obtained authority to cut out the contractor's joints, and adopt my own method of heating the compound by means of charcoal, which gives a dry heat. For this purpose I had a brazier made, and this was the pattern for those now in universal use in the Service. There being sufficient slack in the cable for the purpose, the old joints were entirely cut out and fresh joints made, by which means the insulation of the cables was restored.

Then followed other types of low capacity lead-sheathed cable, such as the "Fortin-Herman," which comprised four revolving conductors, each conductor being insulated by means of wood beads. These conductors were very loose in the lead sheathing, and in jointing it was very difficult to distinguish the diagonal wires. This really could only be judged by getting the best electrical results. A few of these cables were laid in the Thames Embankment Subway, between Blackfriars and Westminster, but they were not brought into extensive use.

(*To be continued.*)

NEW COMMON BATTERY EXCHANGE AT CARDIFF.

By T. DEVEREUX.

A NEW common battery exchange, intended for the use (until 1911) of the National Telephone Company, is at present under construction at the Cardiff Post Office.

An extension of the building has been made to provide room for the new equipment and for the various offices and dining-, cloak-rooms, etc., for the use of the Company's staff. A separate entrance has been provided in Park Street so that the tenancy of the premises by the Company will cause no inconvenience so far as the presence of the different staffs on one building is concerned.

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The Exchange will have a capacity for approximately 10,000 subscribers, an equipment of 4600 being provided at present.

The main distributing frame is situated in the basement, in the same room as the frame serving the Department's existing Common Battery Exchange. A two-position engineer's desk is also provided.

Lead-covered cables, each accommodating 200 lines, convey the subscribers' circuits up the existing chute on their way to the Intermediate Distributing Frame. It will be seen from Plate 1 that in the same room as the I.D.F. are also contained the line and cut-off relay, meter, and junction apparatus racks and the fuse-board. A lamp cabinet is not included, as the line resistance lamps have been dispensed with. Current from the 24 V. battery passes through the line relay on to the subscribers' "B" line; leakage of current on this line is shown up by the glowing of the subscribers' calling lamp. It will be noticed that a 4 V. tap is not used, and no provision is made for automatically showing up a fault on the "A" line.

The line and cut-off relays are wired from the vertical side of the I.D.F., and are numbered to correspond with the operators' panel numbers.

Owing to a large proportion of the lines being rented by "flat" or "inclusive rate" subscribers, and no record of their calls being therefore necessary, only 2300 Service meters have been provided, and these are wired by means of 21-wire cables to 100-tag connection blocks fixed at the top of the vertical side of the I.D.F. Single "jumper" wires will be run from the "test" tag on the horizontal side to these blocks in the cases of the subscribers' circuits requiring the use of meters. On circuits having no service meters, the operator's meter will be sensitively adjusted to operate through the cut-off relay.

The "A" positions in the switch room comprise twelve 9-panel sections, with a 3-panel "dummy" section at each end. The answering positions have a capacity for 50 jacks and lamps per panel, the present equipment being 40 per panel, so that each position will accommodate 120 subscribers.

The out-going junction shelf has capacity for 600 lines, with an equipment of 100, multipled every six panels, and the subscribers' multiple comprises 4600 lines multipled every eight panels.

The last operator's position is fitted as a testing position, the test and plugging-up lines connected with the engineer's desk being terminated upon it, while it is also equipped with a volt-meter for testing purposes, and a howler to gain the attention of subscribers who may have left their receivers off the hook.

The subscribers'-operators' cord circuit is very similar to that shown in Fig. 8 of the article on "Common Battery Telephone Transmission Systems, etc.," in the April issue of this JOURNAL, the

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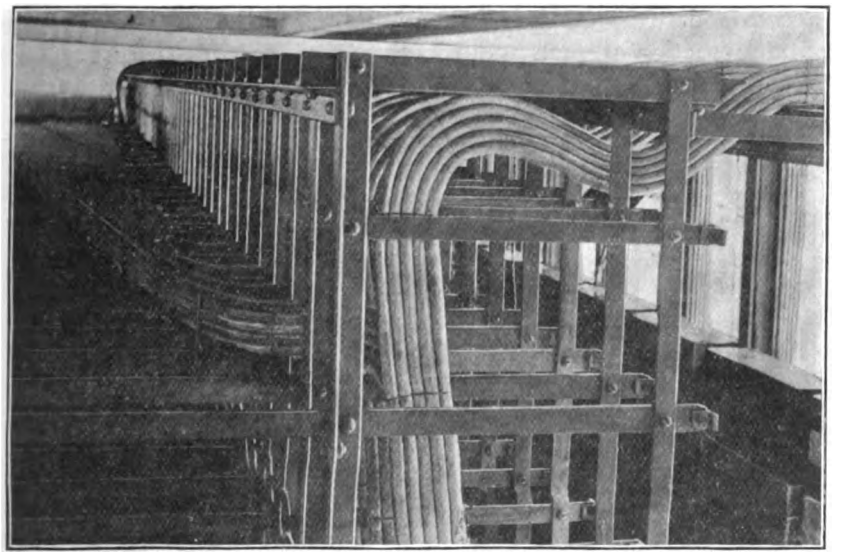
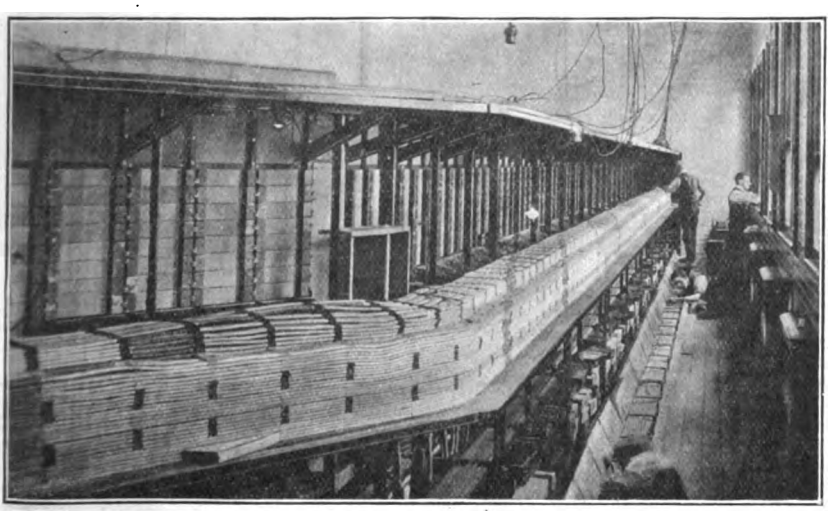
difference, as will be seen on reference to Plate 4, being that the supervisory relays and retardation coils are each wound to 50 ohms,

TOP OF I.D.F., SHOWING ANSWERING CABLE-RUN AND CABLES FROM VERTICAL SIDE GOING TO LINE AND CUT-OFF RELAYS.





VIEW OF PORTION OF MULTIPLE SHELF, SHOWING CABLES AFTER COMPLETION OF CLAMPING.

I

and that their relative positions in the "A" and "B" lines are reversed. It is found that the reduction in the windings of the coils brings the circuit fully in line with that of the Western Electric

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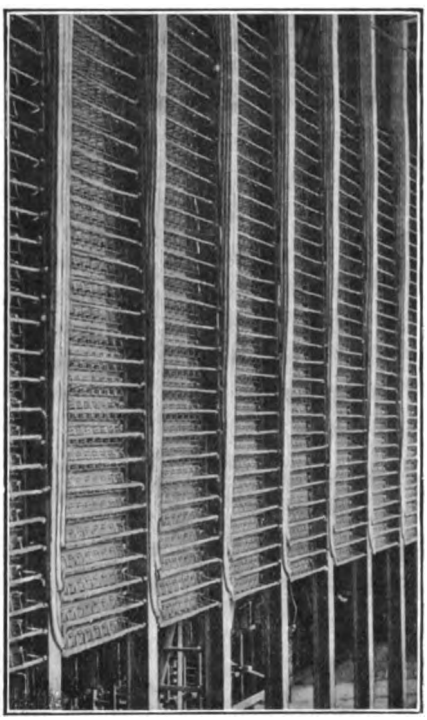
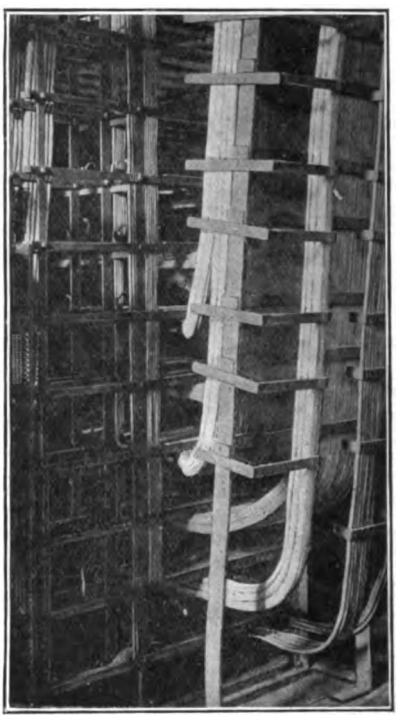
Company as regards speaking efficiency on lines with low resistance in the transmitting circuit, and that as regards reception the alteration has the effect of slightly improving the already high efficiency of the Helsby circuit.

On the junction side two 3-position sections (each position to accommodate 27 incoming junctions) are provided, with a 2-panel dummy section at each end, together with a cable-storing section. The junction sections are wired for 81 trunk junctions, 27 magneto-



WIRING OF LINE AND CUT-OFF RELAYS.



VIEW OF I.D.F. SHOWING MULTIPLE CABLES LEAVING FRAME.

2

junctions, 42 both-way junctions, and 12 junctions incoming from the Department's existing Exchange in the same building. The subscribers' lines and the outgoing junctions are multipled on this side every six panels.

A brief description of the "two-way" junction circuit may be interesting. The lines will be multipled on the outgoing junction multiple on both sides of the room, while they will also be joined to the "B" positions for incoming calls. It will be seen on reference to Plate 5 that the outgoing portion of the circuit is completed through the armatures of the 30ω cut-off relay, which is actuated on

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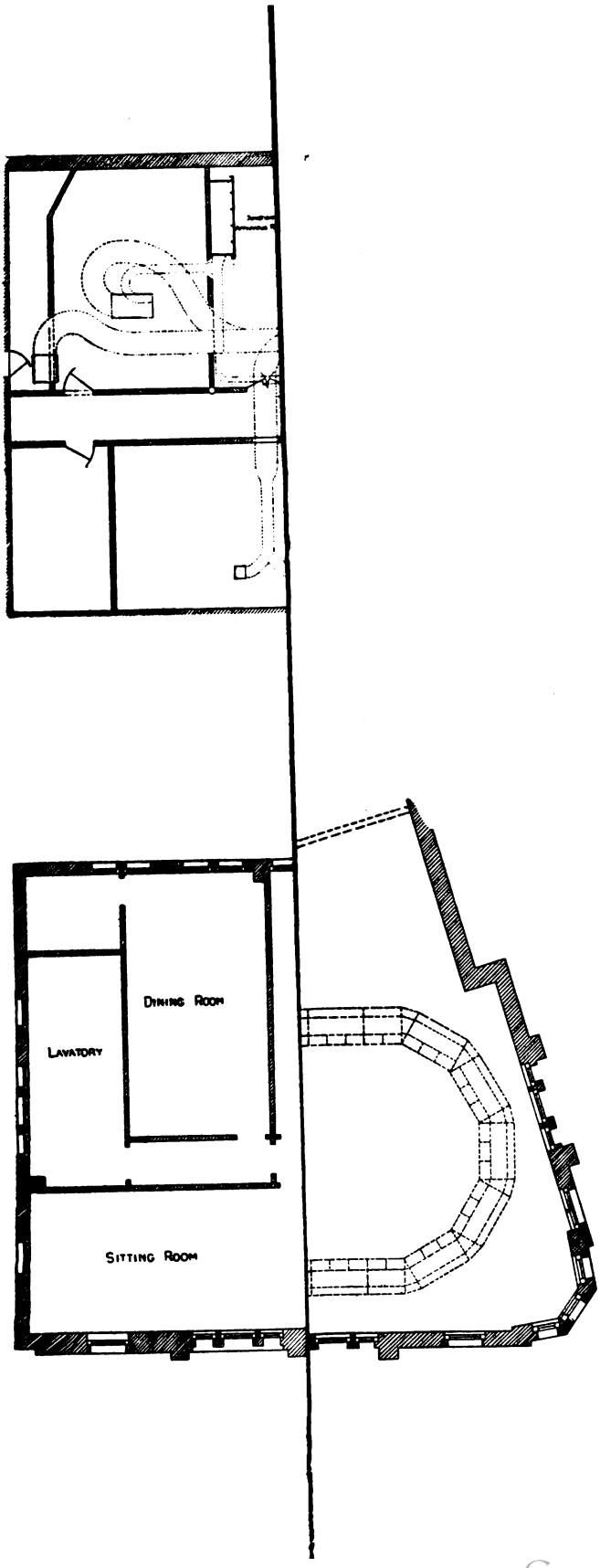

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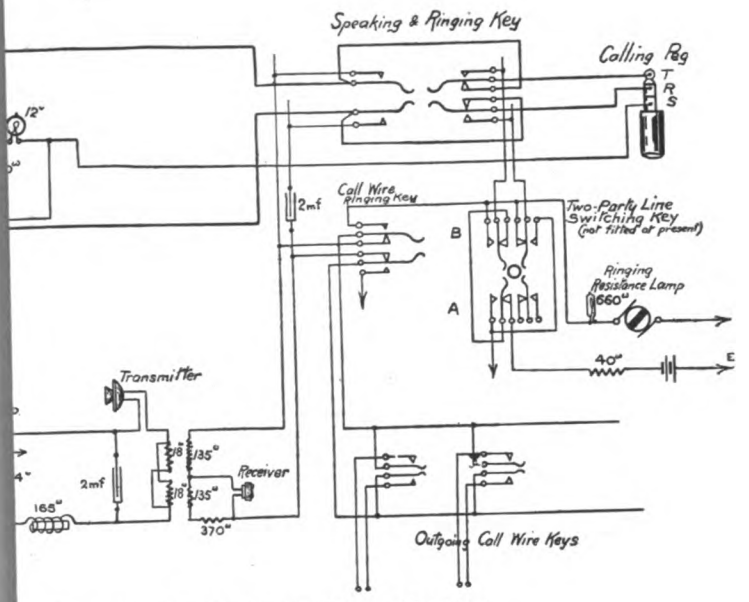
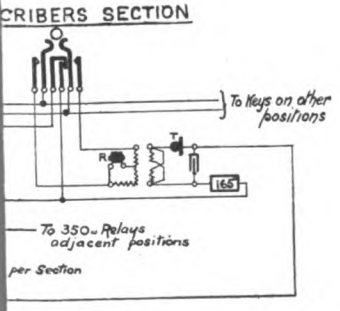


ED OPERATORS' SPEAKING AND METER CIRCUITS.



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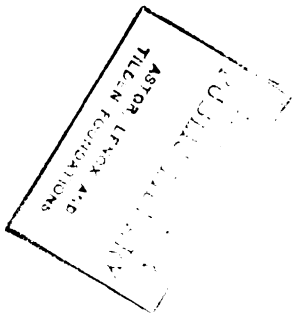

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the junction being taken up for an outgoing call, while at the same time the apparatus on the incoming junction position is cut out. If, however, the circuit is being taken up for incoming purposes the engaged test is put on the outgoing junction multiple bush through the 1000ω resistance spool and the left contact of the 350ω relay. The current flowing through the 1000ω coil and the 30ω relay is not sufficient to actuate the latter, and the normal connections of the incoming side are thus retained. It will be noticed that two pairs of supervisory relays and retardation coils are required for each circuit, the one pair being used solely for signalling to the incoming position from the distant Exchange, which in this case will be worked magneto, and the other pair for the usual supervisory purposes.

Desks for the chief operator, exchange manager, and monitor, the two latter each with two positions, are provided, the wires to the desks being conveyed in 42-wire lead-covered cables run in W.I. pipes laid in the floor.

The monitor will be provided with an instruction circuit to the "A" positions, by means of which conversation can be effected with all the operators simultaneously (see Plate **6**). The monitor on pegging in earths the sleeve of her peg through the 30ω cut-off relay, and thus allows battery to flow in series through the 3·8ω relays, one of which is provided for each section. The pulling up of this relay completes the circuit of a lamp on each of the three operators' positions at each section. This lamp is provided with a green cap. Each operator on receiving the glow depresses a spare call-wire key to which the instruction circuit is wired, and by so doing brings her telephone across the line, and at the same time, by means of the two special springs, completes the circuit of a 350ω relay and cuts off the lamp. The operator then listens to the instruction which the monitor requires to give, the circuit being again normal on the call-wire key being released and the peg withdrawn at the monitor's desk.

The Exchange will be run from the existing power plant, with the exception that sufficient plates will be added to the two sets of secondary cells, which are at present only partially fitted, to bring them up to their full capacity of 3060 ampère hours at the 9-hour rate. Separate ammeter shunts will be provided for the 24 V. and 30 V. battery leads to permit of the amount of current taken to work this Exchange being measured.

An extensive scheme of underground work is being carried out in conjunction with the Exchange equipment, a description of which, however, cannot be attempted here.

The writer has to acknowledge his indebtedness to the British Insulated & Helsby Cables Limited, who have been entrusted with the carrying out of the Exchange equipment, for the copies of diagrams, etc., accompanying this article.

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DEVELOPMENT OF THE POST OFFICE LONG-DISTANCE TRUNK EXCHANGE SYSTEM. (A) TRAFFIC.

By J. STUART JONES.

AN analysis of the particulars relating to the long-distance telephone service of the United Kingdom, which have been published in the Annual Reports of the Postmaster-General during the past eleven years, that is, since the acquirement by the State of the trunk lines of the National Telephone Company, furnishes much interesting evidence of the great development of this branch of the public service. The number of calls made during the twelve months ending March 31st, 1898, was 5,888,247, while the number made during the twelve months ending March 31st, 1908, was 21,993,113, an increase of 273·5 per cent. during the ten years. The revenue for the year ending March 31st, 1898, was £133,974, and for the year ending March 31st, 1908, £535,104, an increase of 299·4 per cent. during the ten years. The most significant testimony to the well-being of the service is, however, the great improvement which has been effected in the annual number of calls carried, and the annual revenue earned, per mile of circuit, in spite of the fact that during the past ten years the mileage of the system has increased three-fold. The actual figures year by year are as follows:

Year.	Circuit mileage.	Number of trunk conversations.	Revenue.	Average number of calls per mile.	Average revenue per mile.
	Miles.		£		£
1897–98	27,860·5	5,888,247	133,974	211	4·80
1898–99	31,554·5	7,066,609	167,505	223	5·30
1899–1900	34,856·5	8,091,631	191,701	232	5·49
1900–01	38,415·5	8,980,733	211,209	233	5·49
1901–02	41,651	10,080,716	238,720	242	5·73
1902–03	46,736·5	11,574,229	274,835	247	5·88
1903–04	51,399·5	13,467,975	325,525	262	6·33
1904–05	56,371·5	15,461,822	380,308	274	6·74
1905–06	64,031·5	17,974,039	439,003	280	7·01
1906–07	70,905	19,803,363	480,658	279	6·77
1907–08	79,676	21,993,113	535,104	276	6·71

Many things have contributed their share to this result. The switchboards and the other mechanical appliances of the system have been gradually improved, and the efficiency of the operating staff has steadily risen; but the chief factor has been the alteration, almost amounting to revolution, in operating methods, which has been effected during the past four years. Obviously in such a system

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as the trunk telephone service it becomes increasingly difficult year by year to raise the output per circuit mile, and the fact that the years showing the most rapid rate of growth were those in which the operating methods were largely altered is a proof of the efficacy of the changes. These changes enabled the existing circuits to carry additional traffic, to accommodate which it would otherwise have been necessary to erect more lines at heavy capital expenditure. The reduction in the circuit-mile averages for the last two years of the period arises from a check in the growth of traffic during those years as compared with the year 1905–6. The growth during that year was very great, and, in consequence, with a view to meet further development, the construction of a large number of additional lines was commenced. The development has not, however, been so rapid as was anticipated.

The fountain-head of all the improvement was the Telephone Call Wire, which was introduced in connection with the London–Liverpool trunk lines about the middle of 1904. Prior to that time all communications passing between the trunk-line operators at different towns and relating to the calls about to be effected were made over the trunk-lines in the intervals between the conversations of subscribers, and the lines had necessarily to lie idle while the attention of the subscribers was being gained. So much of the time of the lines was occupied in service communications and so much unavoidably wasted that it was not often that a circuit carried more than ten 3-minute calls in an hour, even during periods of pressure. After some experiments as to the possibility of introducing in connection with the trunk lines some system of down-call wire working similar to that largely in use for junction work between local exchanges, it was arranged to set aside one of the trunk wires between London and Liverpool for purely service purposes. An operator was continuously in circuit at each end of this service or call-wire, and all service communications between the two exchanges were effected exclusively through the medium of these operators. The trunk lines used for carrying public calls were in this way relieved of service work, and it also became possible, through the agency of the call wire, for the particulars of the subscribers required to be passed from one town to the other slightly before the calls matured. The operators were thus generally able to secure the attention of the subscribers a few seconds before a trunk line became disengaged, and were able to place the subscribers in communication with each other immediately the line became available. The periods of idleness inseparable from the previous method of operating were in this way largely reduced, and the carrying capacity of the trunk lines was, in fact, so increased that during busy periods each circuit of the group usually carried fifteen calls in an hour instead of the

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ten which had previously been the limit, while not infrequently even better results were obtained.

The success of the London–Liverpool Telephone call-wire led to the introduction of similar call-wires at many towns where there were suitable groups of lines, and at one time about thirty such call-wires were in existence. The telephone call-wire had, however, the disadvantage that it withdrew a trunk line from the directly revenue-earning work of carrying public calls, and this disadvantage has led to the general substitution of telegraph call-wires for telephone call-wires. It was at first proposed to use telegraph wires as call-wires where possible, as, being single-wire circuits, they would cost less to maintain than the double-wire telephone circuits; but a telegraph call-wire between London and Manchester which was obtained, towards the end of 1904, by superimposing Morse apparatus on one of the trunk lines, without appreciably interfering with the normal functions of the circuit, proved so successful that all telegraph call-wires are obtained in this manner. The system has been much extended and at the present time about 150 groups of circuits are worked by call-wire. It has sometimes been argued, in view of the complications introduced by telegraph working in connection with the telephone system, that it would be quite as economical to obtain *telephone* call-wires by superimposing. This is true enough, but a superimposed telephone circuit, which is efficient enough for use as a call-wire, is also good enough for use by the public, and the waste of revenue-earning power is, therefore, the same whether the telephone call-wire is a superimposed or a metallic circuit. A few telephone call-wires are still in existence, but in these cases spare wires in telephone cables are available for the purpose.

The benefit of call-wire working, for some time after it was introduced, was, however, confined to expediting the handling of direct town-to-town traffic, that is, of calls effected by means of the call-wire group only. It was of little service for expediting calls involving the combination of two or more trunk lines. The usefulness of the call-wire in enabling subscribers to be called in advance of their calls maturing on the trunk lines had full scope in the case, for example, of a call between subscribers in London and Liverpool. The operators at each town had practically the same work to perform; they knew when a trunk line would become disengaged, and they were thus able so to shape their movements as to place the subcribers in communication with each other with the least possible waste of time. The call-wire, however, failed to be of service when the call was between London and a town beyond Liverpool. If a London subscriber wished to speak to a subscriber at Southport, for example, the particulars of the call could of course be forwarded in advance by the London operator to the Liverpool operator and by

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the latter transmitted to Southport, but it would have been out of the question for the Southport operator, in the absence of knowledge of the conditions of the London–Liverpool service and of the precise time at which a line would be free, to have obtained the attention of the Southport subscriber; and it would have been equally out of the question in the circumstances for the London operator to have obtained the attention of the London subscriber in anticipation of the call maturing. It was therefore the practice, in the case of such a call, to extend a London–Liverpool circuit to Southport; the London operator would then pass to the Southport operator over the trunk line the particulars of the subscriber required, and the line would lie idle while the attention of the subscriber was being gained. In fact, the call was practically operated in the manner followed prior to the introduction of call-wire working, and the benefit of the call-wire was lost. Obviously, in the case of those trunk services where a considerable proportion of the calls involved an intermediate switching, the usefulness of the call-wire was largely nullified, and the question arose whether it would not be possible in some cases for the intermediate exchange to obtain the attention of the subscriber in the terminal town in advance of the maturing of the call on the call-wire group, precisely as in the case of a local subscriber; that is to say, taking the case of a London–Southport call again as an example, whether it would not be possible for the Liverpool operator to obtain the attention of the Southport subscriber in advance of the maturing of the call on the London–Liverpool lines. The Liverpool operator would, of course, know when the call would mature on the lines to London, and she would thus be enabled so to arrange her movements as to have the Southport subscriber in readiness at the proper moment. The arrangement, if practicable, would clearly economise the time of the London–Liverpool lines.

In this idea lay the germ of the method of operating known as zone working, which has since been developed and is now in operation throughout Great Britain. It was evident, at the commencement, that it would be essential that the powers to be vested in the intermediate exchanges should be operative only within definite areas and limited in application to certain services. If the lines between the intermediate and the terminal exchanges were to act as feeders of the circuits forming the call-wire group, it was clear that, in order to secure a proper relation between the two classes, the former should consist of short lines radiating from the intermediate exchanges, while the call-wire groups should consist of the longer and more important circuits. The system of working outlined was accordingly introduced in connection with the London–Liverpool, London–Cardiff, Liverpool–Birmingham, and a few other call-wire groups, all the short trunk lines radiating from Liverpool,

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Cardiff, Birmingham, etc., being defined as the area or zone of operation in each case. The London telephone area was, in the first instance, regarded as the London zone, but this zone has since been extended. The arrangement proved so satisfactory in improving the working of the call-wire groups where it was tried that it was decided to make the practice general. The country was divided into forty-three zones, the arrangement of which was based on the geographical disposition of the various trunk exchanges, and the leading commercial town of each zone was selected as the zone centre. Where the lines between zone centres were too few to form a group for call-wire working, it was arranged to operate them by the method known by the somewhat cumbrous title of "continuous attention." This method of operating, in essence, means that the number of circuits under the control of one operator is so reduced that she is able to keep the transactions under more continuous observation than is possible when she has a normal complement of lines. The operators working such lines are enabled to pass to each other the particulars relating to each call before the call actually matures, and, by attending to the calls in proper sequence, are generally able to obtain the attention of each subscriber before a trunk line becomes disengaged.

All the circuits between zone centres, *i.e.* all the important long-distance lines, are therefore now worked either on the call-wire or the continuous attention system, each zone centre being responsible for obtaining the attention of subscribers at any town within its zone who are required for calls to be effected over lines to other zones.

Lately a further extension of the system has been made. The zone centres, in addition to obtaining the attention of the subscribers, now time the periods of conversation and generally supervise the calls, this work having previously been performed at the originating exchange in each case. The operators at the zone centres are in this way enabled to keep a closer check on the working of the important lines under their charge.

In addition to raising the output of the more important trunk lines, zone working has brought several other benefits in its train. It has enabled the circulation of calls to be simplified; it is contributing to the formation of new call-wire services between zone centres and the minor trunk exchanges of the zones, and it has an important relation to the question of economy in engineering construction.

The introduction of zone working has been too recent for much data to be gathered to show its general effect in raising the circuit-mile averages referred to in the earlier part of this paper. There is much evidence to show that its introduction has led to a much

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quicker long-distance service, yet it is a curious fact that the short lines, *i.e.* the within-zone lines, have not suffered so seriously as might have been expected. The return which is given below of the Glasgow–Greenock working for one day in January, 1908, is of significance. In two consecutive hours the revenue minutes, *i.e.* the time for which subscribers paid, amounted to 46 minutes and 43 minutes per circuit respectively. When it is remembered that the path is not always clear for trunk calls, that subscribers may be engaged locally, that they may be engaged on other trunks, that junction circuits may not be immediately available, that 1½ minutes may be lost in ringing subscribers in those cases where prompt attention is not given, to obtain 43 or 46 minutes revenue out of the total of 60 is no inconsiderable achievement. Short-distance lines, such as the Glasgow–Greenock lines, are liable to be held for the longer distance lines in order that more valuable time may not be lost on the latter. This adds to the excellence of the results shown in the return.

Return of Traffic dealt with on Glasgow–Greenock Trunk Circuits Nos. 1, 2, *and* 3, *on January* 21*st*, 1908, *for each Hour from* 8 *a.m. to* 8 *p.m.*

Time.	Circuits.			Total.	Average per circuit.	Maximum delay.
	1.	2.	3.			
	No. of calls.	No. of calls.	No. of calls.			
8– 9 a.m.	6	4	1	11	3·6	No delay service
9–10 „	7	6	2	15	5	
10–11 „	12	17	17	46	15·3	
11–12 noon	14	13	16	43	14·3	
12–1 p.m.	12	10	12	34	11·3	
1–2 „	10	7	9	26	8·6	
2–3 „	12	10	7	29	9·6	
3–4 „	15	12	14	41	13·6	
4–5 „	11	12	13	36	12	
5–6 „	4	3	3	10	3·3	
6–7 „	6	4	2	12	4	
7–8 „	5	4	3	12	4	
Total	114	102	99	315	105	

But even more remarkable are the results on the long-distance lines between zone centres. Every minute lost in operating on the London–Liverpool lines is worth eightpence, hence the importance of very close operating so that no time may be lost. Returns are taken for one day monthly for every circuit worked by call-wire or continuous attention, and they show a steady improvement. The latest returns show a revenue-time in the busiest hour of 47 minutes

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on the Leeds–Liverpool route, of 46 minutes on the Liverpool–London route, of 49 minutes on the Birmingham–London route, and of 50 minutes on the Birmingham–Cardiff route. This has a remarkable bearing on the efficiency of the routes in respect to delay, for not only does it mean that better revenue is obtained, but that the work is disposed of with a better flow, and the delay is consequently less. Of course, this method of working is only in its infancy, but it is evident that it will be fruitful of good and that the future development of the service in respect to promptness of connection will offer results of which we can only dream at present.

DEVELOPMENT OF THE POST OFFICE LONG-DISTANCE TRUNK EXCHANGE SYSTEM. (*B*) ENGINEERING.

By W. J. MEDLYN.

PRIOR to the transfer of the telephone trunk lines to the Post Office in 1896, the magneto generator call and clear system was in general use by the National Telephone Company for the local exchange services in this country, and it was perhaps natural that the trunk lines should be worked on the same plan.

On the purchase of the lines by the Post Office, however, it was decided to introduce a system of automatic signalling, and switchboards each capable of accommodating a maximum of five trunk circuits were designed. Each trunk circuit was connected through a jack to a line calling relay, and with the latter a separate battery consisting of nine Leclanché cells was associated.

Six pairs of 2-conductor pegs and cords were provided for each switchboard, and across the two conductors of each pair a magneto indicator of the self-restoring type (1000$^{\omega}$) and a galvanometer (1000$_{\omega}$) were joined in series for the receipt of clearing and supervisory signals. One speaking key and two ringing keys were also provided for each pair of pegs and cords.

The general principles of the method of signalling may be explained briefly by saying that the line batteries at each end were joined up in opposition, so that normally, with perfect insulation of the wires there was no current flowing through the line coils of the relays. When a peg was inserted at one end of the line, the relay and battery were cut off and a path was opened for a current to flow from the battery through the relay at the distant exchange, through the line, and through the indicator and galvanometer associated with the cord circuit. The call was thus given automatically, the result

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being indicated to the distant operator by the deflection of a needle on the front of the relay, and, when necessary, by means of a local bell in the armature circuit of the relay. In order to counteract the effect of line leakage which might result in the giving of false calls, three of the nine cells already referred to were joined up in a shunt circuit, so as to keep the needle of the relay normally deflected to the right and the armature held against the back stop. The working margin of the relay was somewhat small, however, especially on the long lines, and in order to ensure the receipt of calls it was necessary to have a ringing battery key associated with one peg of each pair of cords. The ringing battery consisted of ten Leclanché cells, and the connections were such that when the key was depressed the battery was joined up to assist the action of the automatic battery at the distant exchange.

Junction circuits were provided between the Post Office and the local exchange, generally at the rate of one junction for every trunk circuit.

In the largest centres a subscriber of the National Telephone Company requiring a trunk connection passed the necessary particulars to the Company's operator, and the latter repeated the particulars to a Post Office operator over a call wire upon which the latter was continuously listening. The particulars of the call were recorded upon a ticket which was afterwards circulated to the operator controlling the trunk line concerned. In the smaller centres the particulars of the calls were repeated over a service circuit, the attention of the Post Office operator being gained when necessary, by ringing. When a trunk line was at liberty the trunk operator selected the junction circuit to the local exchange, requested the local exchange operator to extend it to the subscriber requiring the connection, and proceeded to call the subscriber by means of the magneto ringing key associated with the pair of pegs and cords in use. At the same time, the trunk operator took steps to obtain communication with the distant exchange subscriber.

On conclusion of the conversation the local subscriber rang off (or was expected to do so), thus dropping the shutter of the indicator at the trunk exchange. On the withdrawal of the connecting pegs the automatic calling battery was applied to the trunk circuit, thus causing a current to flow through the galvanometer associated with the pair of pegs and cords in use at the distant trunk exchange, and giving an automatic clearing signal.

When the conversation was finished, the trunk operators were required to verbally request the Company's operators to clear the junction circuits, a down call wire or service circuit being used for the purpose.

It must be admitted that the theoretical method of working by

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automatic signals was not always obtainable in practice. The battery power available was comparatively small and consequently difficulty was generally experienced in maintaining the delicate adjustments of the apparatus. Owing to the shunting effects of the local exchange apparatus, failures of the generator ringing signals to actuate the drop indicator across the trunk exchange cords were frequent, and to overcome the difficulty the coils of the galvanometer in series with it had to be joined in parellel (250 ω). This alteration reduced the effectiveness of the signal from the automatic battery, as indicated on the needle of the galvanometer, and when combined with the shunting effect of other apparatus and the use of long lines, some discrimination was necessary at times to distinguish between the deflection due to current, and the natural hang of the needle.

When more than two and not more than ten switchboards were installed, direct transfer circuits with automatic signalling were provided for inter-communication between the various groups.

When more than ten switchboards were installed a transfer section was necessary for through switching between the trunk lines. In this case an operator at, say, No. 2 switchboard, on being requested to extend one of her lines to another line terminated at, say, No. 11 switchboard, would obtain communication with the later position *via* the transfer section, where an operator was stationed for the purpose of effecting such connections.

In four of the largest exchanges, viz. Birmingham, Glasgow, Manchester, and Leeds, secondary cells were provided for the operators' transmitters and for local signalling on the various indicators within the exchange. At all other exchanges primary batteries were used. At the four exchanges named primary batteries were also used for independent signalling on the trunk lines, as already described—nine cells for each line.

One of the first steps in the direction of improvements was to introduce a battery at the Post Office for sending an automatic clearing signal to the local exchange operator on the withdrawal of the connecting peg from the junction line jack.

With the growth of the system it soon became evident that at the large exchanges the use of primary batteries for line signalling would be a serious tax on the building accommodation, and on the maintenance charges, and in 1897, when the writer was in charge of the engineering arrangements at the Leeds Trunk Exchange, he devised a scheme for using secondary cells on the "Universal" system, in place of the independent primary batteries for line signalling. This resulted in the recovery of close upon 1000 cells at Leeds, and as the result of the trial proved quite satisfactory, the system was shortly afterwards brought into general use at the other three exchanges.

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At other important centres a similar system was introduced by working the line signalling primary batteries on the "Universal" system, *i. e.* one battery was joined up for common use on all the lines in each exchange, thus economising space by reducing the total number of cells.

The switchboards of the original pattern met the requirements when the system was comparatively small, but as the exchanges increased in size engineering and operating difficulties began to manifest themselves. The provision of one junction for every trunk line meant low traffic efficiency in the junction service, because the junction lines could not be worked up to their full capacity. During the maximum load periods trunk lines were, of course, occasionally idle, or were connected together for through traffic, and at such times the corresponding junctions would be left idle. It was necessary, however, to have the junction lines available for use when required, in order to avoid loss of time on the important and costly long-distance trunk lines.

In the London Trunk Exchange the junction circuit conditions were somewhat exceptional, owing to the comparatively large number of important local exchange centres within the area. In this case an effort was made to economise the number of junction lines by terminating them on transfer sections so that a trunk operator could obtain communication with any local exchange only with the assistance of a transfer operator in the trunk exchange. In addition to the junction transfer sections, trunk transfer sections for through switching between trunk lines, as already described, were of course necessary, and ultimately the number of transfer sections began to assume a relatively large proportion to the total number of switchboards in the exchange. The numerous transfer sections necessitated the provision of a very large number of transfer circuits with mechanical indicators and 8-point jacks, which gave rise to maintenance difficulties, while the transfer operations involved some unavoidable delay in completing connections, and also involved the provision of extra operating staff, as well as the occupation of corresponding valuable floor space in the exchange and in the retiring rooms.

In 1903 the accommodation available for the trunk exchange equipment in the Central Telegraph Office (London) was found to be approaching the limit, and it was decided therefore to provide an installation of an entirely new design in more spacious rooms at the General Post Office (South).

The details of the new scheme were worked out under the direction of the late engineer-in-chief of the Post Office, Sir John Gavey, and the order for the plant was placed with the British Insulated and Helsby Cables Company.

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The new exchange was opened early in 1904. Full descriptions of the installation were published in 'The Electrician' and the 'Electrical Review,' commencing under the date of February 5th, 1904, but a brief *resumé* of the alterations introduced will no doubt be of interest.

Lamp signalling was employed throughout on the trunk and transfer switches. The trunk line-calling relays were placed on a rack in a separate room, the line-calling lamp being, of course, placed in front of the operator immediately adjacent to the line jack. Lamp signals were also provided for the connecting pegs and cords, the controlling relays being placed inside the switchboard.

Automatic calling on the trunk lines was dispensed with, the operator being required to give a momentary ring from the magneto power generator after inserting a peg into the trunk line jack. Opposing batteries were joined up at each end of the trunk line for giving the automatic supervisory signals on the apparatus associated with the connecting pegs and cords. The junction circuits were multiplied throughout the exchange, one complete multiple being provided for every two trunk operators. The larger groups of junctions were controlled by call-wires, while in the smaller groups a calling signal was automatically displayed at the local exchange when the trunk operator plugged into the multiple. In the latter case a press key, associated with a common lamp controlled by a relay, was multiplied, in addition to the jack, for the purpose of applying the "engaged test."

The calculagraph was also introduced for the purpose of timing the ticket records of trunk conversations. The old system of transfer working for through communications was retained, but space was economised by terminating an increased number of circuits at each transfer switchboard.

In the intervening years the Post Office, in conjunction with the National Telephone Company, had introduced a system of record circuits to enable subscribers to pass particulars of their calls direct to the Post Office operators, thus minimising the risk of error in having such particulars repeated by the local exchange operator under the conditions already described in connection with the method of working which obtained at the outset. Twenty of these circuits as a maximum were terminated on a small switchboard equipped for two operators.

Soon after the opening of the new exchange new methods of handling traffic began to be developed, and the Engineering Department was called upon to devise new arrangements of apparatus and wiring to keep pace with the traffic requirements.

It was found by experiment that if some nine or ten lines existed between any two centres an increase in the carrying capacity of the

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group resulted by providing an additional operator at each end and giving them one of the lines to use as a service call-wire to control the traffic on remaining lines. The call-wire controlling operators passed particulars of the required connections to each other in advance, and the attention of the subscribers was gained in readiness for connection with the trunk line immediately one became free, thus reducing waste, or non-revenue earning, time to a minimum. By working the lines in this way the traffic over the group as a whole was increased, thus more than compensating for the loss due to the appropriation of one line of the group for service purposes.

The usefulness of the call-wire system having been demonstrated, the next step was to devise a scheme for superimposing a Morse telegraph call-wire on one of the trunks in each group, and thus afford the advantages of call-wire working without reducing the number of channels available for public conversations, and without very materially reducing the speaking efficiency of the trunk circuit used for superimposing. The superimposed telegraph circuit was formed on the "bridge" system, with condensors interposed in the telephone leads so as to prevent loss of current used for telegraphing. Single current working with relays was adopted, the local sounder being constructed of small dimensions, and mounted in a head-gear case similar to that of an operator's ordinary head-gear telephone receiver. Tests of the apparatus showed that the arrangement reduced the efficiency of the trunk lines to the extent of approximately two miles of "Standard Cable."

The telegraph call wire worked very satisfactorily, and in view of the consequent saving of wires the arrangement met with favourable consideration from the outset. In fact, demands for the extension of the system soon became so numerous that for some time considerable difficulty was experienced in obtaining supplies of the apparatus at a sufficiently rapid rate.

It is no doubt well known that with the Post Office system of charging for trunk conversations on the "three minutes" unit, it is necessary to time the ticket records at the beginning and end of each conversation. With the calculagraph this timing is, of course, done by stamping the ticket in the machine, but the operator was required to carefully watch the time of commencement stamped on the ticket, in comparison with the clock, during the progress of the conversation, in order to ensure that the authorised limits should not be exceeded. This procedure involved some loss of time, which it was considered might be usefully employed in more remunerative work, and with this end in view an instrument was designed by the writer to give a warning to the operator automatically at the end of each three minutes period. So far as the operating was concerned, a press-key was associated with each line jack and calling lamp, and

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when a peg was inserted in the jack the line lamp was arranged so as to be available for the time check signals. At the commencement of the conversation the operator pressed the key, and at the end of three minutes the line lamp glowed. After an extended trial the experiment was found to be satisfactory, and the general introduction of the time check apparatus for lamp signalling exchanges was decided upon.

A technical description of the telegraph call-wire and time-check apparatus was published in 'The Electrician' of June 15th, 1906.

With the rapid growth of the exchange, difficulties in providing for rapid through switching *via* transfer switchboards became apparent, and a demand was made for direct switching facilities to be provided between all the trunk operators. It was evident that independent direct transfer circuits on the old plan could not be provided, chiefly on account of the expensive and bulky apparatus and the somewhat complicated wiring involved. Some difficulty was at first experienced in devising a suitable method for bringing into use in conjunction with the other apparatus in the exchange, but ultimately a special relay was designed and a multiple system introduced. Each trunk operator was given two answering lamps and jacks, the multiples of which were available to every other operator in the exchange. The automatic call system was adopted, the lamp associated with the answering jack glowing when a peg was inserted into the multiple, but the inner contacts of the answering jack were connected to the operator's telephone so that the operator could make a preliminary reply, if desired, without inserting a peg into the jack.

The connections of the operators' telephones were also modified so that the engaged test could be applied to the multiple by the well-known "click" method.

The multiple transfer installation worked very satisfactorily, and the arrangement not only afforded better facilities for through switching, but a saving of operating staff, and valuable floor space was also effected by the recovery of the transfer sections.

The introduction of the "engaged click" test for transfer multiples naturally opened the way for the application of a similar arrangement in connection with the junction circuit multiples, and it was therefore decided to discontinue the use of the engaged test keys which were originally introduced for this purpose.

The keyboard of the trunk switches was originally arranged so that a trunk operator could, if necessary, push over a key and disconnect the local subscriber while she was engaged in obtaining the connection over the trunk line. The connections were subsequently altered so that the operator, by manipulating the keys, could speak to the local "home" subscriber, or to the distant trunk

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operator independently, without removing either of the pegs from the jacks.

With the development of the system the working of the independent record table switches already referred to began to give trouble owing to the difficulty of providing for an equal distribution of the traffic among the operators. One operator was often temporarily overpressed, while at the same time another operator would probably be idle, the switchboards not being suitably designed for team working. A scheme was, therefore, devised for terminating all the record lines on one distributing switchboard so that the record operators could be utilised to the best possible advantage. The lines were terminated on jacks, each of which was associated with a calling lamp. Each record operator's telephone, upon which she was required to listen continuously at the record table, was connected with a peg and cord at the distributing switchboard, each peg being associated with a clearing lamp. On observing a call, the switching operator selected a disengaged record operator's peg and inserted it into the corresponding jack. This operation automatically lighted a supervisory lamp in front of the record table operator. After noting the necessary particulars on a ticket the record operator was required to press a key to send a clearing signal to the switching operator, who then severed the connection.

The arrangement worked very smoothly and the operating was of such a simple character that an attendant at the distributing switch was able to extend calls to the record table at the rate of from 800 to 1000 per hour.

After the completion of the London Trunk Exchange similar installations were provided at Cardiff and Birmingham, and slight modifications of the same pattern have also been installed at Newcastle-on-Tyne, Blackburn, Oldham, Sunderland and Manchester. Installations similar to the London one have also now been provided at Glasgow, Liverpool and Bradford.

In addition to the introduction of improved apparatus of the lamp signalling type at the large trunk centres, the telegraph call-wire system has been applied generally throughout the country, and various changes have also been introduced in the apparatus equipment at the smaller trunk centres.

In conclusion it may be interesting to quote an extract from 'The Electrician' of February 19th, 1904, where the Editor, commenting on automatic devices in connection with the London Trunk Exchange installation, remarks as follows:

"In the new trunk telephone exchange to which we refer, a successful attempt has been made to produce a common battery luminous signal board, the operating of which is as simple as possible, although it has to work in connection with a number of other

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exchanges, with calling and clearing arrangements of various degrees of automatism. The result is the most intricate combination of relays and other devices that we have ever seen in a telephone exchange. So far is the principle carried out, in fact, that we should not have been surprised to find on the switchboard a blue lamp associated with an automatic cut-off device to put a subscriber out of circuit should his language exceed the bounds of parliamentary usage."

As in the case of modern local exchange switchboards designed by various administrations, one of the chief objects aimed at in the design of the lamp-signalling trunk switchboard was simplicity of operating, because it was recognised that if this were achieved increased revenue would surely follow. To show that the anticipated results have been achieved as the result of improved apparatus facilities and improved traffic management, it is perhaps only necessary to say that the average number of calls passed over each trunk line throughout the country in 1906 was approximately 50 per cent. greater than the corresponding figures for 1898.

As regards the maintenance of the plant the cost compares favourably with that relating to large common battery local exchanges of the standard type, and in practice the "intricate combination" of the apparatus does not appear to be a serious item.

I may add that at the time the foregoing extract was published, the three-minute time check was under trial experimentally, but it was not considered expedient to bring it into use quite in the manner humorously suggested by 'The Electrician' Editor.

RICHMOND EXCHANGE—TRANSFER FROM C.B.S. TO C.B. WORKING.

By J. HEDLEY.

A DESCRIPTION of the new C.B. equipment at the Richmond Exchange appeared in the last issue of the JOURNAL, and on Saturday, July 25th, at 3 p.m., the Exchange was brought into use by transferring the working subscribers from the C.B.S. Exchange.

A brief description of the procedure adopted may prove of interest.

SUBSCRIBERS' LINES.

The lines were transferred to the new Exchange, by drawing in lead covered cables, and making teed connections at points most suitable along the various routes. Wherever heat coils B (28·5^{m} to

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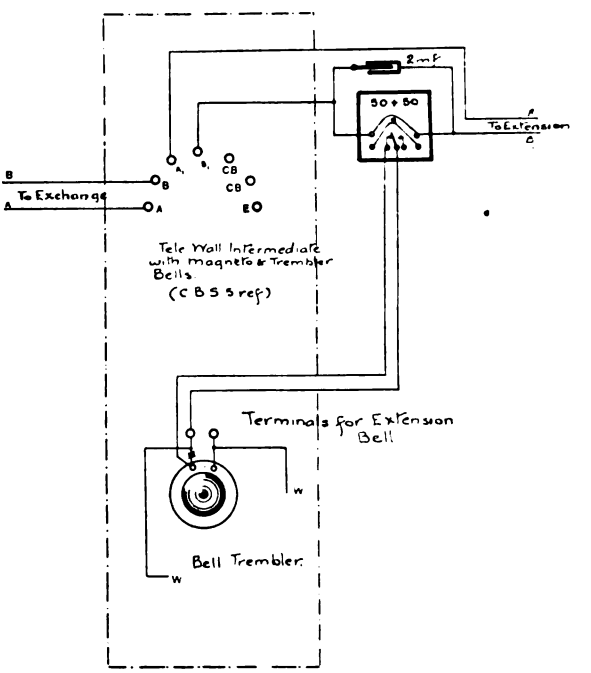
31·5ω) were in existence in the line circuit, they were replaced by heat coils A green (5·5ω to 6·5ω.)

Subscribers' Apparatus.

(1) *Simple exchange circuits*, with or without simple extensions, *i. e.* without inter-communication facilities, did not require to be modified. At the new C.B. Exchange temporary alterations, which will be referred to later, were made which permitted either C.B.S. or C.B. instruments to be used at the subscribers' offices.

(2) *Exchange Circuits with one extension having inter-communication*



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facilities.—Where C.B.S. intermediate instruments (Diagram C.B.S. 5) were in use, the connections of the local bell circuit were modified, as shown in Diagram 1. This alteration was made to avoid a permanent ring on the trembler bell, when the extension was put through to the C.B. Exchange.

Where switchboards wired to Diagram C.B. **21**, were fitted, alterations were made to permit working either on a C.B.S. or C.B. Exchange, as shown in Diagram **2**.

Where wall-boards wired to Diagram C.B.S. **8** were in use, the 1000ω bridging coil, associated with the exchange circuit, was

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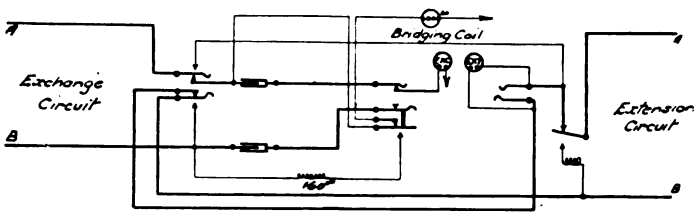
replaced by a coil retardation $80\omega + 80\omega$, with the windings in series, so as to reduce the resistance of the circuit for C.B. working.

It should perhaps be mentioned that in order to avoid complaints of "faint hearing" during the period the C.B.S. instruments would



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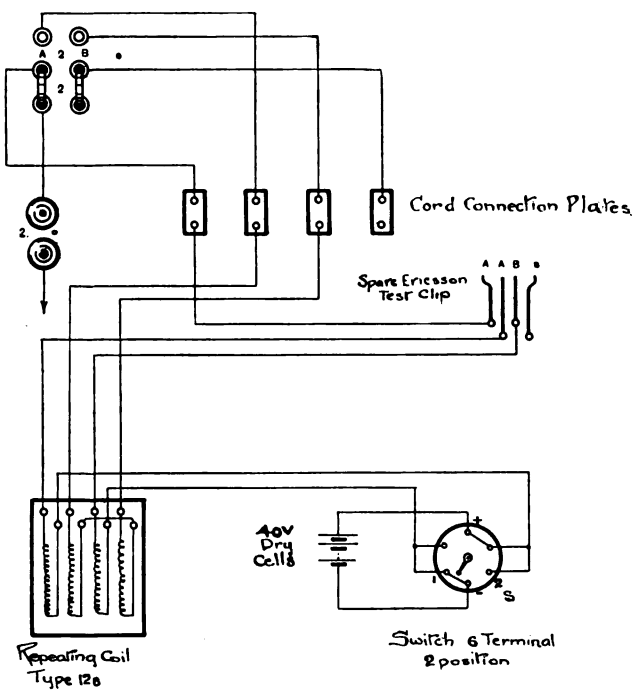
be connected to the C.B. Exchange, a speaking test was made from each subscriber's instrument to the Test Room, so as to ascertain that the subscribers' receivers were connected up in such a way that



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a positive current from the Exchange along the A wire would augment the permanent magnetic field of the receiver. The method adopted for conducting this test is shown in Diagram 3. A positive current is sent out on the A line, when the switch, S, is in position 1, and on the B line in position 2. The 40-volt battery at the Exchange,

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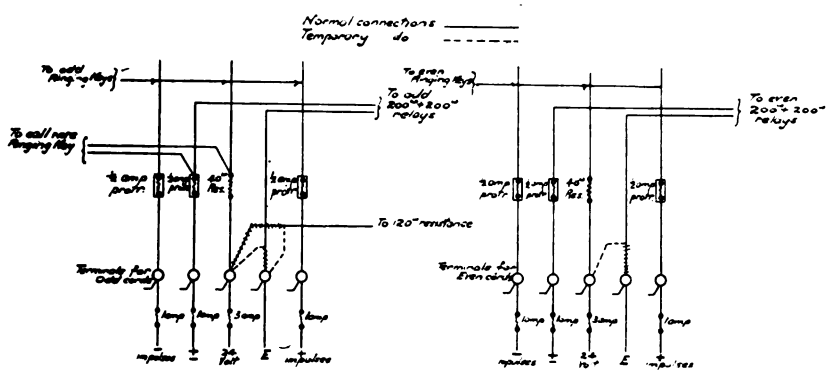
together with the introduction of 1000ω bridging coils in the speaking circuit, enabled the lineman at the instrument to determine without difficulty in which position of switch, S, the hearing was improved, and if this condition was obtained with the switch in position 1, no change was made, but if better reception resulted when the switch was in position 2, the connections on the receiver were reversed.

C.B. Exchange Equipment.

Line Relays.—As previously stated the C.B.S. instruments on simple exchange lines were not modified, *i. e.* the A line remained to earth *via* the 100ω bell, and the other apparatus, which was modified, gave a similar condition. It will be obvious, therefore, that with the normal condition of C.B. Exchange working in London, *i. e.* with the 4-volt tap connected to the line relays, permanent glows



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would be obtained. To obviate this, the line relays were served from the earthed positive pole of the 24-volt battery instead of the 4-volt tap; this alteration was readily made by transferring the main 4-volt lead going to the fuse-board, from the centre terminal (4-volt) of the discharge switch on the power board, to the centre earth-terminal of the discharge switch.

Incoming Junction Circuits.

The wiring of the 4-party line ringing keys, provided in the new Exchange, required to be modified, as, with the subscriber's bell between A line and earth on the C.B.S. apparatus, the tripping relay 200ω + 200ω could not be retained in the generator lead; it was, therefore, placed in the ringing return lead, so that the tripping relay would not operate until the subscriber's receiver was removed. As there were no party-line subscribers at Richmond at the time of the transfer the desired conditions did not involve much re-

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wiring. The commoned earth connection on the inner winding of the relay was reversed with the battery connection on the 120ω resistance spool. This alteration was readily made, as will be seen from Diagram 4. In addition, the machine ringing leads going to the fuse board were disconnected from the centre terminals of the ringing interrupter switch on the power board, and the disconnected positive impulse lead was then connected to the centre alternations terminal. The junction (B) operators were instructed to use "party 4" ringing key for "loop alternating" currents.

In order that the transfer could be carried out promptly, glass separators were placed between the springs of the cut-off relays, so that the battery and calling equipment would be cut off; this enabled the heat coils to be inserted on the C.B. main distribution frame, at any time suitable before the change over. The C.B.S. test frame was of the Ericsson type, which arranges for earthing, as well as disconnecting when the heat coils are extracted; the necessity for dismantling the earth strips prior to the transfer will, therefore, be apparent.

The only other preparatory work necessary for the transfer was the threading of tapes behind the heat coils on the C.B.S. test frame, so that at the time appointed banks of heat coils could be extracted quickly in an easy manner. As the heat coils were withdrawn, the cut-off relays were operated by plugging into the jacks on the new switchboard, so as to release the glass separators, but these operations did not occupy much time. The efforts of the operators to gain the attention of the subscribers were more fruitful than was anticipated, but this was doubtless due to the fact that Richmond is largely a residential district. To obviate any difficulty in transferring the junctions working to other exchanges, the precaution was taken to prove these lines through from the new switchboard, prior to the date of the transfer, and in addition a portion of the circuits to several exchanges were actually transferred an hour in advance of the subscribers' lines.

The number of lines changed over was as follows: Subscribers, 849; incoming call wires and junctions, 49; outgoing call-wires and junctions, 66.

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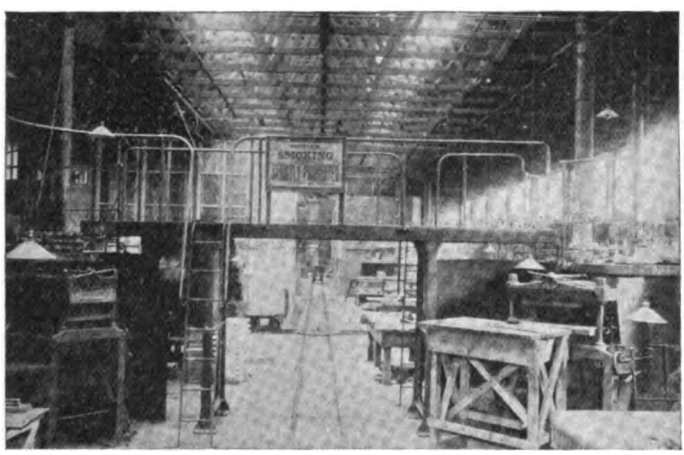
CHLORIDE ACCUMULATORS.

By H. E. MARTIN.

IN response to an invitation from the Chloride Electrical Storage Co., Ltd., the members of the N.W. Centre of the Institution recently paid a visit to the Company's works at Clifton Junction, near Manchester. Having in view the fact that other members of the Institution or subscribers to the JOURNAL may not be in a position to avail themselves of the opportunity of inspecting the up-to-date works of the Chloride Co., it is thought that a little information regarding the manufacture of the "Chloride Accumulator" will prove of interest.

The "Chloride" positive (2) consists of a plate distinct from the



I.—THE CASTING SHOP.

ordinary pure Planté plate, insomuch that it is built up, the active material being a different metal to the frame holding it. The frame is made of a lead-antimony alloy of great strength and stiffness, and rosettes of pure lead are inserted in a series of round holes in the frame. In the making of the rosettes lead tape is first drawn. A vertical press cylinder, fitted with a die having orifices of the desired section of lead tape, is filled with molten lead run direct from a furnace. When the lead is almost cold, the cylinder is driven against an overhead hydraulic ram, which, entering the vertical cylinder, forces the lead through the die, the result being two continuous ribbons of lead $\frac{3}{8}$ in. to $\frac{7}{16}$ in. wide, which are wound on to two wooden drums standing one on each side of the press. The working pressure is 4000 lb. to the square inch, and the weight of lead tape drawn at

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each operation is 448 lbs., *i. e.* 224 lbs. on each drum. The drums are then conveyed to the rosette-forming machines, which, while of a simple character, are very effective, and this remark might be applied to all the machinery observed in the works. The tape is fed into the machine and undergoes three processes — gimping, dividing into lengths, and rolling up into rosettes. The object of the gimping is to give increased active surface. The rolling of the tape is effected by passing it between a milled wheel and spring-controlled rack. The latest type of machine can deliver as many as 4000 rosettes per hour. The buttons are then placed on filling templates. The grids are placed over them, the template is pushed into a stamping-press, and then, under a pressure of 200 tons, the rosettes are all driven into position, standing out uniformly $\frac{1}{32}$ in. on each side of the

2.—Positive Plate.

plate. During the subsequent "forming" process the slight expansion, combined with the fact that the holes in the grids are countersunk on each side, ensures the rosettes being firmly held in position. The process of manufacturing the frame of the positive plate consists in hot metal being run into moulds under an air-pressure of 150 lbs. to the square inch. The moulds are in two halves, mounted on presses in front of the lead furnaces. The castings are then passed through a punching machine, which clears all the holes in one operation, in readiness for the rosettes and the "gates," and any rough edges are trimmed off with suitable tools. The employment of lead-antimony alloy, in addition to giving the plate great mechanical strength, has the all-important advantage that, being inoxidisable, it

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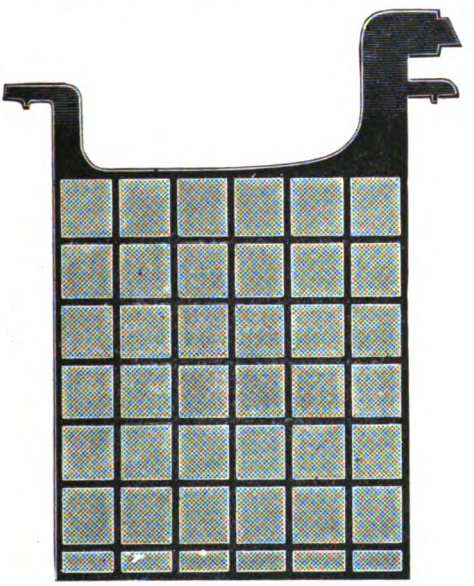
is not affected by the chemical changes which take place during the life of a plate, and consequently the conductivity of the plates is never diminished. The negative plate (3) is known as the "box" type, because it is composed of two sections rivetted together after the insertion of the active material, which is then contained in a series of small cages or boxes. In the manufacture of this type of plate, perforated sheet-lead is cut into requisite sizes and cast on to skeleton frames. In the "mixing" department the paste for the negatives is prepared in rumbling machines, which consist of cylindrical chambers fitted with revolving blades. The paste is carefully weighed out and applied to the frames, which are then rivetted



3.—Negative Plate.

together under a special press. The grouping of the positive and negative sets is carried out in another department. The plates are evenly spaced in racks, and assembled on special casting tables fitted with moulding clamps. In these, at one operation, the strap-connector and plates are united to the section bars. There are numerous other interesting sections, such as the power house, the testing shop, carpenters' and mechanics' shops, the plumbers' shop, where the process of lining wood boxes with lead and building up the metal tanks for large telephone batteries is carried out, the reducing and forming departments, and, by no means least important, the chemical laboratory, where all raw material is tested prior to being issued to the works, and samples of electrolyte and water for use in battery installations are analysed.

A distinctive feature of the "chloride" cell is the wood sepa-

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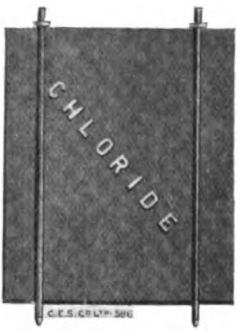
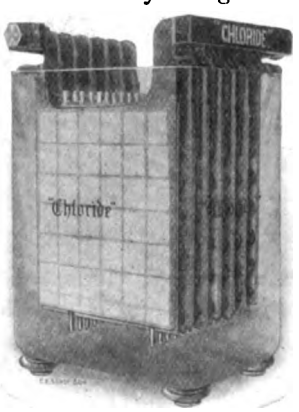
rator (4). These separators are cut to the exact size of the plates for which they are intended, and are held in position by means of wooden dowels, which are suspended from the top edges of the plates. The wood is subjected to a special treatment before being brought into use, which removes from it all substances which would in any way be harmful to the plates. It is claimed for the separators



4.—Wood Separator.

that they tend to maintain the capacity of the plates in a manner which cannot be effected with the ordinary glass or ebonite separator.

Splendid accommodation is provided for the staff. In an industry where practically nothing but lead is handled, the necessity for cleanliness is obvious, and this fact is fully recognised by the Chloride Co.,



5.—Assembled Cell.

who take every possible precaution to prevent lead-poisoning. With the exception of glass-ware, everything required for accumulators is manufactured at Clifton Junction.

In conclusion it is desired to state that the greatest courtesy was extended by the representatives of the Company, and the pains taken to make all explanations clear were greatly appreciated by the visiting members.

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THE POST OFFICE RADIO-TELEGRAPH STATIONS AT TOBERMORY AND LOCHBOISDALE.

By A. C. Booth.

These two radio-telegraph stations were erected for the Post Office by the Marconi Company to supplement the single-wire submarine cable serving the Outer Hebrides *via* Stornoway.

Lochboisdale is situated on the east coast of the island of South Uist, while Tobermory is situated in the north of the island of Mull, where there is direct communication with Oban and Glasgow.

The distance between the two radio stations is sixty miles, almost entirely over sea, but the Tobermory station is, from a radio point of view, rather badly situated, being surrounded by hills. In spite of this disadvantage excellent working conditions prevail and strong signals have been received at both stations from the Marconi stations at Clifden and Poldhu, from the Eiffel Tower at Paris, and from the German station at Norddeich, near Emden.

The erection of the two stations was commenced in October, 1906, but was not completed until the following spring owing to delay caused by bad weather and two accidents with the mast at Lochboisdale.

The equipment of the stations is exactly similar and can be divided into three chief parts, viz. (*a*) the power plant, (*b*) the telegraph apparatus, and (*c*) the aërial structure.

The power plant consists of a 4 h.p. petroleum engine driving a 1½ kilowatt 4-pole converter at a speed of about 1600 revolutions. The armature of this machine has a commutator on one side and a pair of slip-rings on the other, providing either a direct current at 110 volts for charging the secondary cells or an alternating current at 76 volts for working through the spark-coils. When the engine is not in use the secondary cells are used to drive the converter as a motor and thus to supply the alternating current from the slip-rings.

The engine and converter, with the oil and water tanks, occupy a portion of a wooden shed, the other portion being partitioned off to house the secondary cells.

Lead-covered cables convey the current to the operating room, in which is fixed the controlling switchboard provided with the direct and alternating current ammeters, volt-meter, knife-switches, and fuses. The starting and field resistances are placed immediately beneath the switchboard.

To protect the armature coil of the converter from a possible burn-out due to sparking caused by high-frequency oscillations traversing the power leads, two straight filament lamps 150 volts 8 c.p., each

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in parallel with a condenser and a fuse, are joined, one across the leads from the commutator, and the other across the leads from the slip-rings.

The telegraph apparatus is placed in a smaller wooden hut adjacent to, but quite free from, the engine shed, so that no disturbance may be experienced, from the noise or vibration made by the running of the engine. The apparatus can be divided into two portions, viz. that used for transmission and that used for reception. In the former a Morse key is used to complete the circuit of the alternating current through a regulating inductance, and the primary coils of two 10-inch spark coils whose hammer-brakes are out of use, but are available in case the converter should for any reason be out of order. In that case a direct current would be taken from the battery.

As the alternating current is considerable the contacts of the Morse key are substantial, and in order to avoid the injurious effects of sparking, a vibrating key is joined across the Morse key; the tension of the spring of the vibrator being adjusted to break the circuit at the moment of reversal. In addition, a condenser in series with a resistance and fuse, is joined in parallel with the two keys.

The secondary coils of the 10-inch spark coils are joined in series and through two choke coils to the spark-gap, which is in parallel with a high-tension condenser joined in series with a tuning inductance and the primary of an oscillation transformer. The secondary of the oscillation transformer is joined on one side to the aërial wire and on the other to the earth lead, in which is placed a small spark-gap to insulate the aërial when reception is in progress.

The action of the Morse key is therefore to send a low-tension alternating current through the spark-coils, whose secondaries provide a high-voltage current for charging the high-tension condenser through the inductance and oscillation transformer. When the condenser is sufficiently charged a spark passes at the spark-gap and the condenser is discharged causing an oscillatory current to circulate in the circuit made up of the primary of the transformer, the spark-gap and the inductance.

An oscillatory current is therefore produced in the secondary of the oscillation transformer and consequently in the aërial and across the spark-gap in the earth lead to the earth plates. This current causes electric waves to be radiated.

For receiving purposes the aërial is switched on to a transformer in connection with a filings coherer, which controls a sensitive relay working either a trembler bell for calling purposes or a self-starting Morse printer.

The coherer gives a speed of about twelve words per minute,

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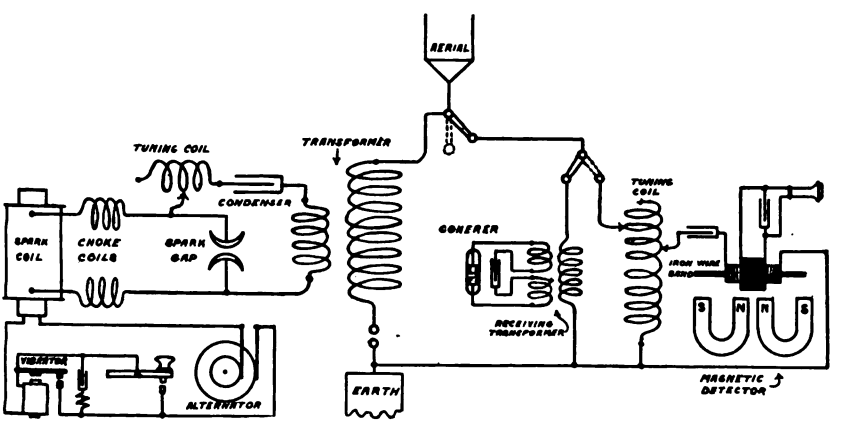
and is too slow for ordinary traffic; but a much speedier arrangement limited only by the skill of the operators is also provided by the magnetic detector which enables the Morse signals to be read as sound signals from a double head-gear telephone. The detector consists of a slowly moving band of fine iron wires passing through a small coil of insulated copper wire. Around this coil is another and larger coil connected to the telephones, while the inner coil is connected through a condenser to the aërial inductance on one side and to earth on the other. These coils are situated in a strong magnetic field produced by two permanent magnets having their like poles adjacent as shown in the figure (1).

Electric waves in passing cause oscillatory currents in the aërial and its connection through the tuning inductance to earth. These oscillations set up other oscillations in the circuit made up of the



1.—Skeleton Diagram of Connections.

small coil of the magnetic detector, the condenser and the tuning inductance, with the result that the slowly changing magnetism of the moving iron band is disturbed, thus affecting the outer coil and producing a slight click in the telephones for each train of oscillations received. Hence Morse signals, which in this system consist of a number of wave-trains, are received as short and long musical notes.

The aërial equipment comprises the mast and its stays (2), the aërial wire proper, and the earth connection.

The mast is 150 feet in height, made up of three portions, spliced and clamped with four iron bands at the joints. The structure is supported by three sets of four stays of 2-inch, 2½-inch, and 3-inch steel and hemp hawsers, securely anchored through several turns of 2- and 3-inch rope lanyards and chains to ring bolts. The rope lanyards are to allow for adjusting the tension in the stays. The

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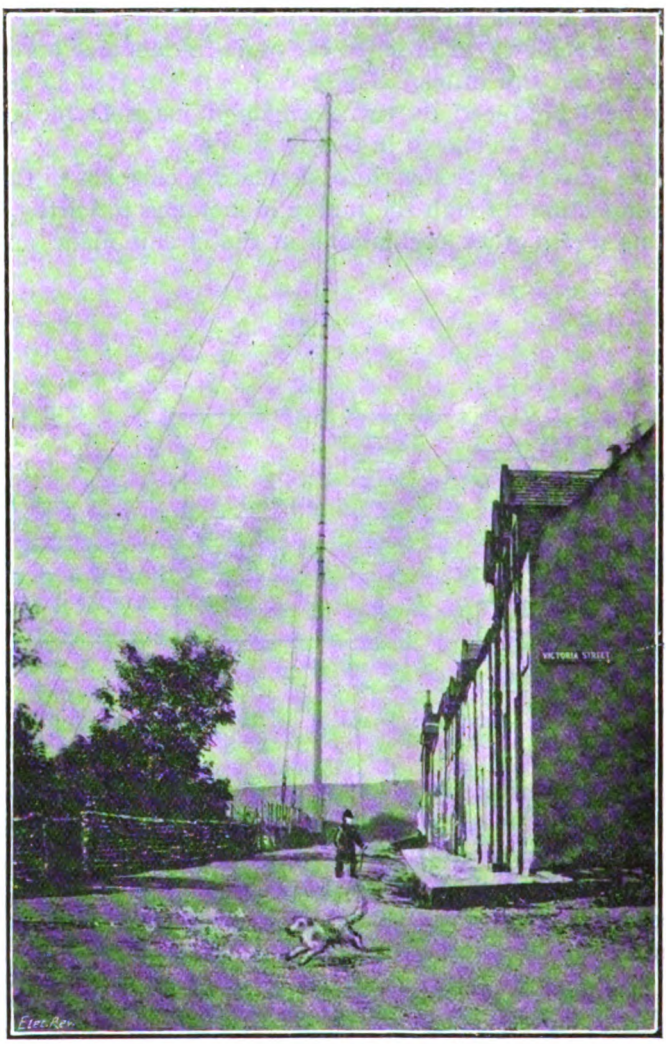
aërial wire consists of two lengths of 7/18 tinned copper separated by two wooden spreaders each 12 feet in length. At the upper end the aërial is insulated by a loop of rope passed through an india-rubber tube about 4 feet in length, while the lower insulator is an ebonite tube through which a brass connection-rod passes.



2.—View of Mast at Tobermory.

The "earth" consists of twelve sheet-iron plates each 5 feet by 2½ feet placed vertically in the ground around the operating hut.

A plug switch is provided for earthing the aërial direct during thunderstorms or when the stations are closed.

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Signals from these stations have been received at the Post Office radio-telegraph stations at Hunstanton and Skegness, a distance of some 400 miles.

EFFECT OF WIRELESS TELEGRAPH TRANSMISSION ON A TELEPHONE SYSTEM.

THE connection of a wireless station in the North of England to the local Telephone Exchange recently gave rise to a somewhat alarming experience.

The telephone circuit was provided in the first instance by an aërial line, two spans of which came within the staying ground of the wireless mast, which is 225′ in height. These wires were not adjacent to or parallel with any leads or wires of the Radio-Telegraph system.

The telephone wires were twisted in the usual way, and immediately outside the station grounds were associated with wires for other local subscribers.

When first installed the telephone circuit was provided with a battery at the station for signalling purposes, both wires being in use for this purpose, as well as for speaking. Under these conditions speech was rendered difficult during wireless transmission. The "spark" system was in use, absorbing some kilowatts of energy. Not only was speaking difficult from the station itself, but other circuits traversing the same routes were also seriously interfered with, the circuits being rendered noisy. False rings were received from time to time by the various subscribers, and sparking was also observed at the terminals of the Exchange indicators, causing some little alarm amongst the operators.

Arrangements were at once made to substitute cable for the aërial line on the station grounds.

Meanwhile, the change over of the local telephone system to common battery working greatly accentuated the difficulty, due no doubt to the fact that one of the wires was then normally joined to earth for signalling purposes. The disturbance under speaking conditions was not of course increased, but heat coils were now burnt out in considerable numbers at the station and Exchange, and the sparking became more evident. Lightning protectors were also affected.

As the suspension of an aërial cable in the neighbourhood of the wireless station did not improve matters a lead-covered cable was buried in the ground and terminated a few yards from the hut by

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means of unsheathed cable. This reduced the disturbance considerably, but did not entirely overcome it, and the lead-covered cable had to be extended into the hut and terminated close to the telephone instrument before the difficulty was entirely overcome.

At the station an "arc" system was also installed, but with these undamped oscillations no difficulty was experienced.

F. TREMAIN.

ON THE PROPAGATION OF PLANE ELECTRO-MAGNETIC WAVES ALONG A PLANE-CONDUCTING SURFACE, AND ITS RELATION TO WIRELESS TELEGRAPHY.

By J. ZENNECK.

(Translated by H. HARTNELL, A.M.I.E.E.)

(*Continued from p.* 151.)

4. *Absorption of the Waves in the Direction of Propagation.*

(*a*) The absorption of the waves in the direction of propagation, *i.e.* in the positive direction of x, is determined by the value of s. If we put s in the form

$$s = -(A - \imath B),$$

$\frac{1}{B}$ is the distance at which the amplitude of the wave is reduced to $\frac{1}{e}$th.

This distance in kilometres is given as a function of σ for various values of k in Fig. 7. The ordinates of the curve are proportional to the common logarithm of $\frac{1}{B}$.

(*b*) These curves show that this distance becomes a minimum for a certain finite value of σ. For smaller values of σ the absorption is less. Since absorption, on the one hand, vanishes when the conductivity is infinitely great, and on the other hand when it is infinitely small, the existence of such a minimum is not surprising.

(*c*) The great influence of the dielectric constant of the conductor comes out very clearly; it has an importance at least equal to that of the conductivity. For $k = 80$

$$\frac{1}{B} = 400 \text{ kil.}$$

Whilst for $k = 2$

$$\frac{1}{B} = 1 \text{ kil.}$$

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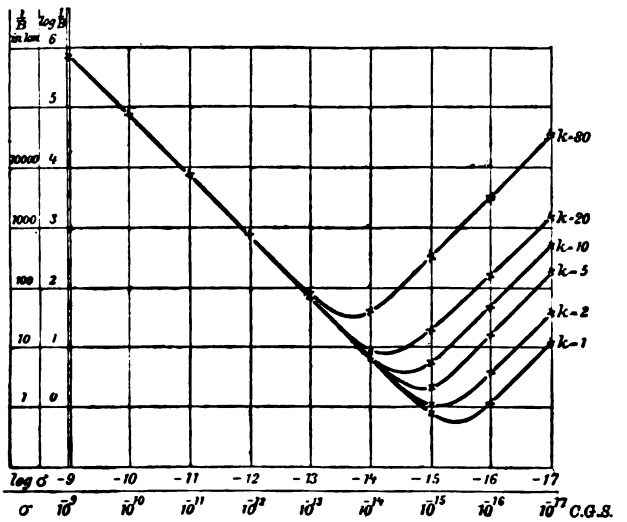
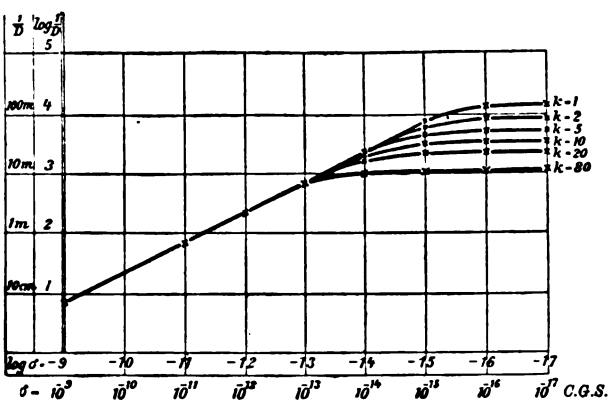
(*d*) So far as the effect of the frequency on absorption is concerned equations 7 give the following rule:

To obtain the length $\frac{I}{B}$ corresponding to a number of alternations



7

A .10^6 it is only necessary to find from the curves of Fig. 7 the value corresponding to conductivity $\frac{\sigma}{A}$ and to divide it by A. For high



8

conductivities the frequency, therefore, has great influence on the amount of absorption until the minimum value of $\frac{I}{B}$ (Fig. 7) is attained. For lower conductivities the influence of the frequency becomes less and less.

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5. *Absorption of Waves by Penetration into the Conductor.*

The absorption of waves by penetration into the conductor is determined in a similar manner from the imaginary part of the co-efficient $r = C + \iota D$. In Fig. 8 is given the common logarithm of $\frac{I}{D}$ (cms.) for the depth at which the amplitude is reduced to $\frac{I}{e}$ of its value at the surface up to 10^{-13} C.G.S. the effect of the constant k is inappreciable, as shown in Fig. 8. For lower conductivities it becomes more appreciable, but never attains the same importance as in the cases already dealt with.

On the other hand the absorption by penetration into the conductor is very great, as may be seen from the figure, if we remember that it is now a question of centimetres instead of kilometres, as in the case of propagation along the surface.

6. *Relations between the Intensities of the Electric and Magnetic Fields and the Velocity of Propagation.*

(*a*) From equation (2) we have:

$$\frac{E_{0z}}{M_{0y}} = -s.\frac{\nu}{\nu\epsilon_0}.$$

Considering the value of s we see that the absolute value of the ratio $\frac{E_{0z}}{M_{0y}}$ is never far from the velocity of light, and that the phase angle between E_z and M_y always remains very small. In general considerations we may regard E_{oz} and M_{oy} as having the same phase.

(*b*) The velocity of propagation c along the surface of the conductor is

$$c = \frac{\nu}{A}$$

(A being the real part of s).

This value may be slightly greater than the velocity of light, and this is doubtless due to the fact that the direction of the waves is oblique with respect to the surface.

(*To be continued.*)

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"HOWLERS, TECHNOLOGICAL."

By EXAMINER.

Question: What is known by the symbols "H" and "B" in electro-magnetics? State what effect the introduction of iron has on the lines of force in a solenoid traversed by a current.

Answer: Symbols H and B stand for hydrogen and battery. The hydrogen of the iron bar allows the current from the battery to pass more freely through the substance of the iron, and the iron bar is made a strong magnet.

Answer: The symbols H and B in electro-magnetics means that the magnet is built up or fixed in position like or somewhat like the letters H or B. The effect of iron coming in contact or introduced into the lines of force in a solenoid would be to disturb and tend to render valueless the lines of force.

The foregoing answers, however, were capped by two other candidates, one of whom said that "the symbols H and B have reference to the height and breadth of coils. The height of a coil is best kept in direct proportion to the breadth"; the other said: "Symbol H stands for $H_2 SO_4$, and B for ——."

Question: What precautions would you take to secure a good earth for a telegraph circuit in the absence of gas- or water-pipes? What objection is there to the use of internal gas-pipes as earth connections?

Answer: In order to ensure a good earth connection for a telegraph circuit, it is absolutely necessary to keep the earth wire from passing into or through a rock as there may be some portions of metal of a different kind than at other places; the result would be that there would be earth disturbances and repeated faults.

In the absence of water-pipes or gas-pipes the wire may have to be carried some distance to say a pit of clay where there is usually a kind of liquid. If the earth wire were connected to an internal gas-pipe as an earth connection there is a probability that there would be an explosion by the pipes becoming heated.

A TRAIN HELD BACK BY A SPIDER.

ON June 4th the 7.10 a.m. train from Ballyhaise Junction to Belturbet on the G.N.R. (Ireland) was detained for 100 minutes owing to a fault in the electric train staff instrument. When the energetic representative of the Post Office arrived on the scene he found

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that a *spider* had got between the contact points and the key lever at Belturbet and so caused a disconnection. It is not on record how many unsuccessful efforts preceded his achievement, but the far-reaching result of his final success doubtless exceeded his anticipations. No such previous case is on record.

REVIEW.*

"THE HUGHES AND BAUDOT TELEGRAPHS," BY A. CROTCH, OF THE ENGINEERING DEPARTMENT OF THE POST OFFICE, is a small treatise dealing briefly with the main features of these highly successful printing telegraph systems.

The illustrations regarding the Hughes instrument and its parts are exceptionally good and are worthy of a fuller description than that provided. The brevity is in fact carried a little too far in places. For instance, on p. 12, in describing the movement of the printing axle click, it is stated that "it is stopped by the shoulder *v.* of the detent arm," whereas it is the portion of the printing axle to which the "click" is attached that is stopped.

On p. 13 the movement of the printing-cam is said to "gradually" raise the printing lever T.; and again, the correcting-cam is said to "gradually" turn round. Both of these movements are, in fact, very rapid, occupying roughly about one sixtieth of a second.

In the first paragraph dealing with letters and figures on p. 15 the type wheel is stated to "always move unit distance or some multiple of it." This conveys the impression that the type wheel has a step by step movement, whereas it is practically continuous.

With the above exceptions the description is good and well ordered, giving ample information for anyone desiring to obtain a working knowledge of the principles of the instrument.

The method of working the instrument is then dealt with, the author giving a description of the various adjustments necessary in order that two instruments may be made to work with each other over a telegraph line.

Duplex Hughes on the Differential and Bridge systems are next described and a full diagram of the connections given. Brevity is again in evidence in the sentence regarding the arms of the Bridge duplex, but is not likely in this case to be misleading: "unequal ratios, however, are not used, and the values of these are 3000 ohms each."

Lastly, repeaters for Hughes simplex and duplex circuits are described and illustrated with diagrams of the very numerous connections. Both these and the photographic reproduction of the duplex board are somewhat out of date, certain changes having been made in minor details, but the principle remains the same.

Under the heading of the Baudot system several pages are devoted to the

* "The Hughes and Baudot Telegraphs," by A. Crotch. Size $7\frac{1}{4}$ in. × 5 in. × $\frac{3}{8}$ in. Price 1*s.* 6*d.* Published by Rentell & Co., 36 Maiden Lane, Strand, W.C.

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Delaney multiplex, simple and duplex, with explanations of the adjustments necessary to secure the passage of the various currents through the proper portion of the receiving apparatus.

Then follows a theoretical consideration of the passage of the signals in the Baudot multiplex, with a description of the "cadence" which is the warning to the operator of the correct moment to form the key combination for the next letter he desires to send.

The alphabet is then given showing which keys are to be depressed for each letter with the resulting currents that are sent to line, and the portion of the combiner in the receiving instrument corresponding to each letter.

The author goes a little astray on p. 50, where he states "it would be useless to send a second series into the translator until it has printed the first and is ready for the next." This actually does occur, viz. that before a signal is printed another set of signals has already been received on the electro-magnets of the receiver.

Good descriptions with ample illustrations of the keyboard and receiver are given, but on p. 61 the "levier d'accrochage" is translated as "hanging lever" whereas it should be "holding" or "locking lever." The same remark applies on the next page in reference to the "locking pin."

In dealing with the function of the moderator no mention is made that it provides a means for altering the speed of the receiver to suit its distributor.

The distributor is next described with illustrations of a front and side view. In the latter it is unfortunate that six brushes are shown on the front plate where four only are used, and the brushes on the rear plate are shown revolving in the wrong direction. The letterpress, however, correctly describes the instrument.

A rather important statement needing qualification is that at the top of p. 78 regarding the rate of the receiver in relation to the distributor. There is no need for absolute accuracy in this respect. The speed of the receivers may vary to some extent so long as they make the same number of complete revolutions as the distributor.

Lastly, a full diagram of the wiring connections is given and a general consideration of a quadruple Baudot circuit. Like the description of the Hughes that of the Baudot might with advantage be considerably amplified; it is, however, a very concise description of a complex subject, and we have no hesitation in strongly recommending this treatise as a carefully compiled and well-written description of two very important printing telegraph systems.

The first is in use in nearly every country of Europe and the other is being rapidly extended.

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NOTES AND COMMENTS.

Telegraphs and Lightning.

The article which will be found on another page of this issue detailing some of the effects produced on a telephone system by the operation of a radio-telegraph installation in close proximity suggests for consideration a fruitful field of inquiry, and one which is now far more ripe for investigation and discussion than it has hitherto been. The vagaries of lightning and the difficulty of forecasting its precise effects are well known. Hand in hand, however, with the development of radio-telegraphy there has of recent years been an increasing need for quantitative measurement and scientific research on the effects of high-frequency and high-tension electrical discharges. The demand has already produced fruit, and ideas are gradually becoming much more exact in these matters as one branch of electrical and physical science becomes welded up to another to confirm or refute hypotheses and assumptions. Though science advances by slow degrees true science is very sure, for so soon as another real truth is added to our store of knowledge it generally becomes possible to confirm it from one or other of the correlated physical sciences, often from a number of sources.

Present-day knowledge of the laws governing electrical discharges and high-frequency effects, though yet meagre enough, is far in advance of the knowledge of twenty, or even ten, years ago. Firmly established theories, however, always die very hard, false though they may be, and orthodox explanations of the effects of lightning and lightning protectors on telegraph circuits are no exception to the rule. For instance, the commonly accepted statement that a simple spiral of wire introduced between a cable and land-line at the point of junction or between line and apparatus will "choke back the oscillations" is dying a very hard death, though on mature consideration it must be obvious that since the self-induction of such a spiral is the main factor which determines its choking properties, and since the self-induction of an open spiral of a few turns is quite small compared with, say, two or three spans of the land-line, its power to choke back oscillations generated by a thunderstorm, perhaps some miles away, must be small indeed compared with that of the intervening part of the line itself. That the spiral is often effective in preventing damage to the cable or apparatus is not denied, but exception should certainly be taken to the explanation of the way in which the result is produced. This is no mere quibble, because unless the method of operation is properly appreciated the natural result is that the remedy is inefficiently or improperly applied. The knowledge gained by familiarity with the varying power of different

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types of electric sparks and discharges to produce effective oscillations in radio-telegraphy appears to shed a different light on the method of operation, which is to be traced to the influence which the self-induction of the spiral exerts on the spark produced at the lightning protector invariably associated with the spiral. How and why the spark occurs is another story that need not be entered into here. Any considerable oscillations which occur will be set up locally as a result of the lightning protector discharge, and if this discharge spark is to have the proper characteristics of an oscillatory spark it must be traversed by extremely rapid oscillations. The self-induction of the associated spiral is quite sufficient to so far reduce the natural period of oscillation that the spark is practically "killed." In the light of familiarity with wireless telegraph effects it is therefore probable that the function of the spiral is to kill the spark at the protectors, not to "choke back the oscillations."

Less need be said in refutation of the idea that fuses introduced between overhead and underground work in place of protectors will serve in any way to protect from lightning effects, though the idea still appears to hold in some quarters. Possibly it has arisen from the fact that substitution of protectors by fuses, if it has occurred, has resulted in less frequent trouble. This may well be if, as appears probable, the protector itself is the thief which causes some of the very trouble it is expected to remove.

Lightning protectors of the standard type will often be found to be a source of trouble in proximity to radio-telegraph installations, as it is quite easy to render a telephone circuit unworkable during the operation of a radio installation in the proximity by simply adding a lightning protector, whereas without the protector no trace of interference existed. Fortunately for wireless telegraphy, whose field would be hampered if it interfered seriously with wire telegraphy or telephony, it is possible to so arrange and operate both systems side by side that not the slightest interference is produced.

First International Congress of European Telegraph and Telephone Engineers at Budapest.

This is an age of conferences, and leading men of science and commerce everywhere recognise the value of periodical meetings for the purpose of promoting their common interests.

It is therefore somewhat remarkable at first sight that European telegraph and telephone engineers, whose business it is to provide and extend inter-communication throughout the world, and whose lines are necessarily extended to each other at numerous points, should not hitherto have arranged to meet in conference.

The desirability of such a course has long been recognised, but

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numerous difficulties—largely due to the vastness and complexity of the interests involved—required to be overcome before a conference could be arranged.

The French Administration long ago proposed such meetings, and the matter was subsequently taken up by the Hungarian Technical Staff, to whose untiring energy and enthusiasm we owe the conception of the first Conference at Budapest, which was held from September 21st to September 29th. Delegates were present from Great Britain, France, Germany, Bavaria, Austria, Italy, Belgium, Holland, Denmark, Sweden, Roumania, Bulgaria, Servia and Russia.

Great Britain was represented by Major W. A. J. O'Meara, C.M.G., Engineer-in-Chief to the Post Office and President of the Institution of Post Office Electrical Engineers, Mr. T. F. Purves, Staff Engineer (one of the editors of this JOURNAL), and Mr. J. G. Hill, 2nd-Class Engineer.

The titles of Papers given at the Conference are appended herewith :

(1) "Automatic *v.* Manual Telephone Exchanges," M. Karl Barth v. Wehrenalp (Austria).

(2) (*a*) "Types of Underground Cable Employed in France"; (*b*) "Method of Working Telephone Trunk Circuits in France"; (*c*) "The Various Types of Baudot Telegraph Installations," M. Bazille (France).

(3) "The Underground System of the British Isles," Major W. A. J. O'Meara.

(4) "Telegraph Intercommunication and Concentration Switchboards," and the "Application of Central Battery Working to Telegraph Switching," Mr. T. F. Purves.

(5) "Practical Aspects of Telephone Transmission," Mr J. G. Hill.

(6) "Impedance of Telephone Circuits," M. Giovanni di Pirro (Italy).

(7) "The Best Apparatus for Steady Currents," M. Salvatore Montinari (Italy).

(8) "Disturbances Caused on Telegraph Wires by Currents from Electric Railways: Means of Remedy," M. Enrico Mirabelli (Italy).

(9) "Current Constants of Telephone Circuits," M. Béla Gáti (Hungary).

The publication of the papers and the discussion upon them will be awaited with considerable interest.

This, the first conference of its kind, will doubtless be the forerunner of numerous other similar ones, and we welcome it heartily as an influence which will make for unification of method and efficiency of working, and last, but not least, will tend to strengthen the bonds of mutual respect and good fellowship among the technical representatives of the telegraph and telephone services throughout Europe.

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Station List Supplement.

In response to suggestions from several readers we have arranged to publish station lists, in which we hope to give the present "whereabouts" of all Post Office engineers. As far as possible the rank and seniority position of each officer will be indicated, but the lists are, of course, unofficial.

As it seems probable that readers will wish to keep them separate from the JOURNAL we have had them printed as supplementary pages and with the lists on one side of the paper. They can therefore be preserved and arranged as their possessors may desire.

Sir W. H. Preece, K.C.B., F.R.S.

We regret to again disappoint our readers in regard to the promised article by Sir W. H. Preece on "Pre-Post Office Telegraphs," but we feel assured that in the next issue the same will appear. Sir William notifies us that he is making such good progress towards recovery that he is confident that the MS will be ready. All will be glad to hear of his convalescence.

STAFF CHANGES.

BRITISH POST OFFICE. ENGINEERING DEPARTMENT.

PROMOTIONS.

Name.	Appointment.	Previous Service.
Wilson, H.	Staff Engr., 2nd Cl.	Tel., Newcastle-on-Tyne, 1882; Relay Clk., Eng. Dept., 1892; Engr., 2nd Cl., 1896; 1st Cl., 1902.
Machugh F. H.	Suptg. Engr.	1871; Insp., 1878; Engr., 1st Cl., 1893; Asst. Suptg. Engr., 1902.
Probert, J.	Suptg. Engr.	E.T. Co., 1864; Asst. Supt. School of Telegraphy, 1872; Supt. of Elec. Ltg., 1889.
Tresize. J. M. G.	Asst. Suptg. Engr.	Engr., 1897; Staff Engr., 2nd Cl., 1902.
Crompton, C.	Asst. Suptg. Engr.	Tel., Liverpool, 1885; Jr Clk., Eng. Dept., 1886; Engr., 2nd Cl., 1894; 1st Cl., 1900; Staff Engr., 2nd Cl., 1907.
Lever, G.	Engr., 1st Cl.	3rd Offr., "Monarch," 1891; 2nd Offr., 1892; Ch. Offr., "Alert," 1893; Engr., 2nd Cl., 1901.

DEATH.

Ward, J.	Prin. Clk.	Clk., 2nd Div., M.O.O., 1884; E.-in-C.O., 1882; Clk., 1st Cl., 1900; Prin. Clk., 1907.

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FOREIGN AND COLONIAL NOTES.

(*Specially written for* THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL.)

AUSTRALIAN NOTES.

New South Wales.—The first installation of a common battery system is now being taken over in Sydney Central Exchange, and an extension is contemplated. Hitherto the Central Exchange has been a branching multiple made by the Western Electric Company. There are multiple boards of different types in various branch exchanges in the Sydney Network, and many branch exchanges with 100-line standard boards and special incoming junction line positions.

Since the introduction of the Measured Service Regulations on February 1st, 1907, the rate of increase of telephone subscribers has been double that for any corresponding previous period, and extensive additions to the plant are in contemplation.

The Sydney Network is blessed with a fairly extensive system of tunnels in the centre of the city. These tunnels are for the exclusive use of the Postmaster-General's Department, and furnish an almost unlimited avenue for telephone expansion in the central area. Stoneware conduits are being extended from these tunnels in every direction as occasion demands and as funds can be made available.

In the country districts of New South Wales there has been a rapid expansion of small exchange systems connecting with the country post offices and also great extension of telephone communication, utilising existing telegraph lines by superimposed methods.

Victoria.—The Central Exchange in Victoria possesses one of the oldest series break-jack single-wire multiples in existence. In only one of the branch exchanges is there a multiple switchboard, although two of the branch exchanges have recently been fitted with multiple B positions, to remove immediate congestion, although in those exchanges the A positions still remain as 100-line standard Boards.

An extensive scheme of reconstruction for the whole of the area has been prepared, and includes new buildings and new switchboards for the City, Windsor, Hawthorne, Canterbury, and Brunswick Exchanges, and alterations to the existing equipment at others.

An underground system is also being commenced, and will consist of tunnels in the centre of the city, with stoneware conduits radiating therefrom.

The country district expansion in Victoria is growing in the same ratio as in other States.

Queensland.—Brisbane: A common battery switchboard is about to be installed and the subscribers will gradually be transferred to this board from the present branching magneto multiple installed in 1897.

South Australia.—At both Adelaide and Port Adelaide common battery switchboards are being installed. In Adelaide an underground system of conduits has already been completed and cables are being laid in readiness for a transfer to the common battery system. The introduction of electric traction in this city, which is to take place at an early date, renders it imperative that this change should be completed at about the same time.

Western Australia.—An underground system is also being introduced into Perth, and the introduction of a common battery switchboard at both Perth and Fremantle is in contemplation.

Tasmania.—A common battery switchboard was brought into use in Hobart about a year ago, and one is now being arranged for in Launceston.

Generally speaking the telephone development in Australia is exhibiting the same characteristics as in other parts of the world.

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CORRESPONDENCE.

To the Editors of THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL.

MULTIPLICITY OF INSTRUCTIONS.

SIRS,—No one appears to have taken up the question raised by "Perplexed" in the April JOURNAL regarding the question of indexing the various instructions issued by the Department. This cannot be on account of the want of importance of the subject, as many officers must be equally perplexed with your correspondent when necessity arises for finding any particular instruction, which may be only hazily remembered. As I placed informally before the authorities a suggestion which has not yet borne fruit, will you allow me to indicate the lines on which an "infallible" index might be framed. It is based on the Dewey system of classification adopted in great libraries. To meet our requirements each circular issued would deal with one subject only, and would bear in the top right-hand corner in bold print a number and date thus: $\frac{2\cdot132}{\text{Nov. } 07}$.

The number to the left of the decimal point would not exceed nine and would indicate the group or subject to which the circular referred. These subjects would be very wide ones, but should cover the whole of the business of the Department. The decimals would indicate the subdivisions of these subjects.

Suppose the subjects were somewhat as follows:

1·000 Wayleaves,
2·000 Estimates,
3·000 Construction and Apparatus,
4·000 Sub-heads,
5·000 etc. up to 9,

it follows that the circulars could be sorted into nine groups.

To sub-divide a group let us consider No. 3:

Construction and Apparatus, 3·000.

3·1 Indoor work,
3·2 Outdoor work,
3·21 Covered,
3·22 Open,
3·221 Pole-lines on roads,
3·222 ,, on canals,
3·223 ,, on railways.

In similar fashion, by using the decimal places, all the main groups could be split up and the *papers* could be arranged in numerical and chronological order by a boy copyist. Engineers would be furnished with a "key" drawn up as indicated, and when seeking instructions regarding the construction of, say, pole-lines on roads, would call for group 3·221. In fact the method, taken backwards, is on the lines of the "House that Jack built," for suppose it were required to trace mentally the group to which the glaze on an insulator belonged it would be—

The glaze on the insulator,
which is on the spindle,
which is on the arm,
which is on the pole,
which is on the road, canal, railway,
which is open work,
which is out-door work,
which leads to Group 3 according to the key.

It should be added finally that a master set prepared at headquarters and circulated would enable every office to be brought into line, and I venture to think this would be a great boon to engineers who belong to the migratory genus.

Yours faithfully,
H. P. STEED.

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To the Editors of THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL.

MULTIPLICITY OF INSTRUCTIONS.

ONE welcomes the introduction of the above subject in the April issue of the JOURNAL. Without doubt, it is a matter that lies at the very root of office organisation, and an interchange of opinions on the part of your correspondents cannot fail to be helpful.

Any efficient method of dealing with a mass of varied records must be a simple one, and in a Department like ours it is very desirable that all offices should have their records kept in the same way, so that an engineer going from one section to another would not be at a relative disadvantage by reason of the change.

The writer thinks that the adoption of the following system would put the matter on a perfectly satisfactory footing :

(*a*) All instructions to date should be divided into clearly defined groups, and be replaced by Standard Instruction Books covering all the points. (For convenience, in certain cases, the book might be printed in sections.)

(*b*) Each Instruction Book should have a distinctive coloured cover, and in cases where sections are printed separately all of them should be of the same colour, but distinctively marked in some other way (say with a large number).

(*c*) The Instruction Books should be thoroughly indexed before issue by the engineer, or other officer responsible for their compilation, for he alone will be in a position to bring out in the index the salient points. Poor indexing may reduce the value of the work immeasurably.

(*d*) The Monthly List should then become a medium for distributing only addenda to the Standard Instruction Books. These addenda should be pasted into the Instruction Books only when they modify an existing instruction. New instructions should be kept in the standard file of the Monthly List until dealt with under (*j*).

(*e*) Every office should be supplied with a small card index cabinet of say six drawers, all the drawers being empty. A small supply of blank white cards and alphabetical spacing cards should accompany the cabinet.

(*f*) Each issue of the Monthly List should be accompanied by a batch of printed index cards for insertion in the cabinet. These cards should cover the instructions in the current issue.

(*g*) As the circulars in the Monthly List will each be an addendum of some Standard Instruction Book, each printed index card should be coloured—and marked if necessary, *vide* (*b*)—to agree with the cover of book concerned.

(*h*) All cards of the same colour should be kept separate in the cabinet from cards of other colours.

(*i*) In course of time the cabinet will begin to appear as though it is nearing the limit of its capacity, and this will be evidence that one or more of the Standard Instruction Books requires revision and reprinting.

(*j*) The reprinting of the book having been carried out, it should be issued with instructions to destroy all cards in the cabinets of that particular colour, together with such early numbers of the Monthly List as may no longer be required.

(*k*) The white cards issued with the cabinet are for use in indexing local records and general correspondence.

By this means would be ensured automatically—(1) a uniform system of indexing instructions; (2) the revision of Standard Books of Instructions; (3) the death, after a reasonable period, of the filed copies of the Monthly List; (4) the destruction, when not required, of the portions of the index covered by a reprinted book.

It will be interesting to have from sectional engineers and others any criticisms on the system suggested above.—Yours faithfully,

B. O. ANSON.

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To the Editors of THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL.

EXAMINATIONS.

IN your editorial notes and comments in the last number you welcome the arrival of the Selection Committee who are examining second-class engineers for first-class engineerships.

Second-class engineers under the old *régime* had not to pass such an examination when their turn for promotion to first-class engineerships arrived.

We were selected in the main from the class of telegraphists for special qualifications in the way of certificates in scientific and technological subjects, and we obtained our sub-engineerships and engineerships after passing the recognised departmental examinations.

We had every reason to believe that we should obtain first-class engineerships—as in the past—by seniority and special fitness as shown by past work.

We cannot say by what system the second-class engineer in France proceeds to the higher appointments, but we do know that officers in the postal administration must be under thirty years of age if they wish to enter the École Professionelle preparatory to becoming second-class engineers. Many of us are over that age already.

The following extracts are worth comparing :

NOTES AND COMMENTS.

"They do these things better in France."

We hope the account of the French system will turn attention in this country to the possibility of founding a State school to train telegraph and telephone engineers for the Empire; a school in which students recruited from the staff and from outside could obtain a thorough theoretical and practical training. ('THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL,' July, 1908.)

ACROSS THE CHANNEL.

"They do these things better in France" was a favourite saying of our forefathers. In those days there were a good many things that they did better in France: in these days perhaps there are still some—but telephony is certainly not one of them. ('National Telephone Journal,' July, 1908.)

THE TELEPHONE SERVICE IN FRANCE.

A complete reform was necessary . . . in the selection and training of the staff in the general business administration of the Department and in its financial management. ('The Electrician,' July 10th, 1908.)

THE ARMY.

The examination system which the Chinese are giving up after trying it for more than five thousand years has come to our army with absurd intensity. The outlook of a young officer is a series of examinations. It is not because our officers are deficient in mental ability and vigour that they dislike these ordeals. Indeed, many of them are fond of study, and pass examinations for promotion as well as in languages with great credit. They do not like, however, to have examinations held over their heads like a whip, and made to cause uncertainty and anxiety. ('Chambers' Journal,' July, 1908.)

RUSSIA.

A recent visitor from Russia was asked why the telegraph and telephone systems in that country were in a backward state, and his reply was to the effect that the staff thought too much about examinations and too little about their practical work.

JAPAN.

A Japanese visitor recently intimated that the examination system was unknown in Japan—"They had no time for it," was his comment.

OUR COMMENTS.

We do not for one moment say that examinations are not necessary, but we urge that to enforce them at each and every stage of an officer's career is unnecessary, and detrimental to the real well-being of the Service.

The results of the tried British system may be judged by the large number of visitors we receive to study our methods.

In the outer world men rise without examinations—even Cabinet Ministers. The test of their ability does not depend upon an examination. It is based on past work.

SECOND-CLASS ENGINEER.

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STUDENTS' SECTION.

In this section, so far as space allows, answers will be given to any questions of general interest from an educational point of view. Queries should be addressed to Mr. A. W. MARTIN, Engineer-in-Chief's Office, G.P.O. West, E.C.

CITY AND GUILDS OF LONDON INSTITUTE EXAMINATIONS, 1908.

HONOURS TELEPHONY.

QUESTION 4.—Give the names of the units and show the symbols generally employed to represent (*a*) capacity, (*b*) inductance, (*c*) electromotive force, (*d*) magnetic flux.

What is "reactance"?

Answer.—(*a*) Capacity is usually denoted by the letter K, but sometimes by C. The unit is the *farad*.

(*b*) Inductance is usually denoted by the letter L. The unit is the *henry*.

(*c*) Electromotive force is usually denoted by the letter E, but sometimes by V. The unit is the *volt*.

(*d*) Magnetic flux is generally denoted by the letter N. The unit is the *maxwell*.

(*b*) The effect of inductance in an alternate current circuit is to impede the rise and fall of the current strength. It is possible to show that—

If C be the effective current strength in ampères,

E ,, impressed E.M.F. in volts,

L ,, inductance in henrys,

R ,, ohmic resistance,

p ,, 2π times the frequency,

$$C = \frac{E}{\sqrt{R^2 + p^2L^2}}$$

The quantity $\sqrt{R^2 + p^2L^2}$ is called the impedance, and pL, which virtually acts as spurious resistance, is called the *reactance*.

The effect of capacity in a circuit is reverse to that of inductance. If an alternate current circuit contain resistance and capacity without inductance the *reactance* is $-\frac{1}{pK}$ where K is the capacity in farads.

If both inductance and capacity be present in a circuit the total reactance is the algebraic sum of that due to L and K respectively, or $pL - \frac{1}{pK}$.

Reactance may be said to be that part of the impedance in an alternate current circuit which produces the same effect as resistance on the strength of the current, and which causes a difference in phase between the impressed electromotive force and the effective current.

ORDINARY TELEGRAPHY.

QUESTION 2.—(*a*) How many cells of 2 volts electromotive force and negligible resistance would be required to send a current of 30 milliampères through an external resistance of 2450 ohms?

(*b*) Show why it is that a larger number of circuits can be worked on the universal system from secondary than from primary batteries having the same total electromotive force.

Answer.—(*a*) The general rule is that if—

e be the E.M.F. of each cell in volts,

r ,, resistance of each cell in ohms,

R ,, external resistance in ohms,

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C be the current strength in ampères,
n „ number of cells required,

$$C = \frac{ne}{R + nr}$$

r in this case = 0, so that—

$$C = \frac{ne}{R},$$

$$\text{and } n = \frac{CR}{e},$$

$$n = \frac{0{\cdot}030 \times 2450}{2} = 36{\cdot}75$$

or 37 cells.

(*b*) An important difference between secondary and primary cells is that the former have no (or negligible) internal resistance while every form of the latter offers an appreciable amount.

When a steady current flows through any conductor, whether it be a battery or a wire, a fall of potential occurs therein which is equal to the product of current strength in ampères and the resistance of the conductor in ohms. In any complete circuit if E and r be respectively the E.M.F. and resistance of the battery and R the resistance of the external circuit, the current C will be found from—

$$C = \frac{E}{R + r},$$

$$\text{or } E = CR + Cr.$$

The latter expression means that of the total E.M.F. a portion, Cr, is utilised in urging the current through the resistance of the battery, and the remainder, CR, is available for sending the current through the external circuit.

It should be clear that if the internal resistance of the battery is negligible, as is the case with secondary cells, there can be no fall of potential in the battery, and the whole E.M.F. of the latter is available for urging current through any external resistance, and this no matter how strong the total current may be; but with primary cells the greater the strength of the current flowing through the battery the greater will be the proportion of the total difference of potential absorbed in the cells, and consequently that remaining for external use will diminish.

The current flowing through each of a number of circuits joined in parallel depends only upon the difference of potential between the ends of the battery to which they are joined *after all the circuits have been completed*. As no fall of potential takes place in a secondary battery, the difference of potential between its ends is constant and the current in a circuit joined to it is of the same strength, whether that circuit alone is completed or whether it be one of a large number. With primary cells the more circuits there are joined to the battery the greater becomes the fall of potential in it owing to its internal resistance, the less, therefore, will be the available potential difference between the extremities of the battery for external work. In this case the current in a particular circuit will not be the same when it alone is "joined up" as will be flowing when a number of others are connected in parallel.

SOCIAL NOTES.

SOUTH METROPOLITAN CENTRE.

KINGSTON-ON-THAMES TELEPHONE EXCHANGE.

A LAUNCH trip, organised by the engineering and commercial staffs of the Kingston Telephone Exchange, took place on Saturday, June 13th. The large steam launch "La Burgoine" was chartered, and left Kingston for Egham at 3 p.m. with a party of 130 on board.

Mr. H. Hardie kindly provided gramophone selections during the afternoon, and

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after tea had been served an excellent musical programme was commenced. Mr. Bariscale, of the Gaiety Theatre, London, very kindly consented to assist, and his songs, viz. "Sincerity," "Gra McCree," and "Off to Philadelphia," were enthusiastically received. Miss E. Payne presided ably at the piano, and Miss B. Eldridge's performances on the violin were also much appreciated, Misses Armstrong, M. Cawthorn, E. Radcliffe, E. Dear, Thornton, E. Thompson, Messrs. Costello, F. McDermott, B. Wood, Hibbard, and Hill, contributed to the vocal portion of the programme, and the talent displayed was of a high order.

The Committee, which consisted of Miss M. Cawthorn, Messrs. H. Radcliffe, and A. Wakely, had evidently spared no effort to secure the success of the trip, and their aim was certainly achieved.

Mr. and Mrs. Harrison and family were present, as also were many officers of the Headquarters and local staffs of the Metropolitan (South) District.

It is proposed to arrange a second outing of a similar nature in August next.

THE NATIONAL TELEPHONE BENEVOLENT SOCIETY.

THE Entertainments Committee of this Society ask us to announce that they have arranged the following events for the coming winter: Four Lectures, four Whist Drives, Two Dances, a Social Evening, and a Smoking Concert. We have pleasure in doing so, and further particulars can be obtained from the Hon. Sec., Mr. F. C. French, Salisbury House, London Wall.

CLUB NOTES.

LAWN TENNIS MATCH.—ENGINEERING DEPARTMENT *v.* STORES DEPARTMENT.

THIS match was played under very favourable conditions on the ground of the Highgate, Bohemians L.T.C. on June 29th, and resulted in a win for the Stores Department by 5 events to four. Most of the games were well contested and the result as far as sets and games were concerned was in favour of the Engineering Department, *i. e.* 12 sets to 10, 108 games to 105, so that the honours were very equally divided. Considerable difficulty was experienced by both sides in ascertaining the best available men, and it is hoped that at next year's meeting both departments will be represented by stronger teams. The scores were as follows:

H. W. Fulcher and E. H. Walters (Engineering Department) beat T. B. Barker and G. H. Macgregor, 6–4, 6–4; beat W. M. Cook and P. Green, 6–1, 6–1; beat H. E. Willmott and A. Burt, 8–6, 6–1.

A. H. Shepperd and A. E. Thorne (Engineering Department) lost to Barker and Macgregor, 3–6, 3–6; lost to Cook and Green, 6–2, 0–6, 4–6; lost to Willmott and Burt, 8–6, 2–6, 2–6.

J. E. T. S. Hilton and A. Warren (Engineering Department) lost to Barker and Macgregor, 9–7, 0–6, 7–9; beat Cook and Green, 6–3, 6–4; lost to Willmott and Burt, 6–3, 4–6, 4–6.

H. W. F.

INSTITUTION NOTES.

MEETINGS of the Council were held at Bath on May 27th and 28th, 1908, and Matlock on July 22nd and 23rd, 1908, under the chairmanship of Mr. A. J. Stubbs.

The popularity of the Central Lending Library is well maintained, and the demand for books has been above the average for the season of the year. The stock of canvas pouches for the transmission of books has been found to be inadequate, and the Council have taken steps to obtain an additional supply.

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It will be observed from this year's Annual Report that the accounts of the Institution have been subjected to a professional audit. In view of the growing importance of the Institution's work the Council have considered it desirable to substitute a professional audit in this and in future years.

The Council have arranged to reproduce the front covers of papers printed by the Institution, in order that members may have their sets bound into volumes, if they so desire.

The question of altering the constitution of the Council has been engaging the attention of the Council for several months. Schemes of representation, based on either a purely geographical or a purely class basis, have been discussed, but it has been unanimously agreed, after careful consideration, to continue the present constitution.

The membership of the Institution has increased from a total of 755 on March 31st, 1908, to 781 on July 20th, 1908.

A suggestion has been made that the services of University Professors, Lecturers, etc., should be requisitioned in order that lectures on subjects of special interest to members might be arranged at Local Centre meetings during the coming session. A committee of the Council has been appointed to ascertain whether anything can be done in this direction.

OBITUARY.

Mr. Joseph Ward, Engineer-in-Chief's Office.

Died at Leytonstone, August 29th, 1908; aged 44.

It is a trite saying of obituary writers that "Earth is the poorer" for the loss of the individual whose death they would incite us to mourn. But nobody who knew Joseph Ward will even dream of doubting its special applicability to his being and doing. Life was to him a school in which, as an apt pupil, he was daily learning *how to live*, and his death has set some of us wondering at the extent of our ignorance upon the problem. In him Life overcame Death. As we remember how he lived, we almost lack interest in the question of how he died. The last Enemy was really his best friend, in that it set him free from mortal pain, widened the scope of his vision, and enlarged his sphere of service. He could even afford to be humorous in the article of Death, for he was hopefully ready!

To write anything like an "official" tribute to a colleague whose inborn repugnance to red-tapeism seemed in its strength well-nigh comparable to his love of right and loyalty to duty, were a thankless task, and might even appear an affront to his memory. Within the wide range of His Majesty's Civil Service there was, it is no exag-

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geration to suggest, not to be found an officer with higher ideals of conduct. He was always Joseph Ward, a veritable genius in many of his conceptions, and, like unto not a few—let it be believed—of his surviving colleagues, devoted and true.

He had served in the Post Office for well-nigh a quarter of a century. Entering the Savings Bank Department in or about 1884, he was some two years later transferred to the office of the Engineer-in-Chief, and for a considerable period was attached to the Plan Section. Subsequently he was removed to the Estimates and Works Order Section, and there, under the writer's supervision, he speedily gained the unreserved confidence of his fellow-workers. Almost at once, thanks to his sterling qualities, he became the object of general respect, which with some of us quickly, and almost unconsciously as we found, had been merged in friendly regard, and ultimately had deepened into sincere affection. That a like process in the measure of appreciation, both of his gifts and graces, was also passing in the minds of his successive chiefs, we recognised evidence in their increasing trust and marks of approval, until, to the gratification of practically every brother officer, he was announced a Principal Clerk, in charge of the Staff Section. For that responsible position he soon convinced us all of his exceptional fitness, for it had been written of him upon the tablets of human hearts that "he loved his fellow-men." He was keenly discriminating in his judgment, tactful, uniformly kind and wise, while his love of goodness and truth amounted well-nigh to a passion. His unselfishness had passed into a proverb amongst us, and somehow it happened that every would-be critic of the "true and undefiled religion" defined in New Testament phrase was at once silenced by the living illustration of its power, furnished in their comrade, "Joe Ward."

We do not believe that God has destroyed the mould in which our colleague was made; nor can we for a moment give place to the idea that there is not still available an ample supply, for each and all of us, of the unseen might that had transformed him into so noble a soul, and of the beneficent love that sustained and directed its delightfully self-extinguishing exercise. So that it remains for us who are survivors to let our wreath upon his grave be a quietly serious resolve to impersonate his simplicity and faith, seeking to avoid even those inevitable mistakes and failures which the best of men do not always escape. T. H. S.

COMMUNICATIONS.

All Communications should be addressed to the Managing Editor, 22, G.P.O. West, E.C.

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INTERNATIONAL CONFERENCE OF GOVERNMENT TELEGRAPH AND TELEPHONE ENGINEERS.
BUDA-PEST. SEPT. 1908.

D.Cimponeriu (Hungary), E.Berdenich (Hungary), L.Lázár (Hungary), S.Haltenberger (Buda-Pest), E.Rédl (Hungary), J.Hollós (Buda-Pest), E.Fritz (Hungary), Bela Gáti (Buda-Pest), B.Paskay (Hungary), K.Hansel (Austria), T.M.Barthel (Dresden), C.Holzmann (Buda Pest), Dr Mirabelli (Rome)

H.C.Dietl (Vienna), F.Pattevicz (Austria), H.K.Steidle (Munich), F.Schaden (Buda-Pest), E.Ratkovszky (Buda Pest), M.Müller (Germany), B.Juicher (Hungary), T.F.Purves (London), L.Komarnicki (Buda Pest), U.Tanasescu (Roumania), Prof. di Pirro (Rome), W.Herz (Germany), J.Fodor (Buda Pest), M.Ivcevic (Austria)

W.Gadomski (Austria), A.Sándor (Austria), F.Gutzmann (Berlin), E.Wittichen (Frankfort), J.Vater (Buda-Pest), A.Hultmann (Stockholm), E.Günther (Halle), A.Major (Hungary)

F.Stecher (Austria), P.Balla (Buda Pest), J.G.Hill (London), C.Vidic (Roumania), A.Marini (Roumania), K.Havelik (Austria), A.Kraatz (Berlin), R.Knabe (Austria), A.Stegu (Austria), F.C.Proper (Holland), M.O.Filenek (Austria), M.Gebhard (Germany)

Hassan Ferid (Constantinople), S.Montinari (Rome), N.Rousseff (Bulgaria), F.Stegmann (Munich), G.M.Radacovitch (Bucharest), K.Barth von Wehrenalp (Vienna), Major O'Meara (London), A.Kolossváry (Buda Pest), Dr Strecker (Berlin), A.E.R.Collette (Amsterdam), B.E.vangoulow (St Petersburg), A.Rydin (Stockholm), C.E.Krarup (Copenhagen), M.Emin (Constantinople)

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SPECIAL CONFERENCE NUMBER.

THE
Post Office Electrical Engineers' Journal.

THE FIRST INTERNATIONAL CONFERENCE OF TELEGRAPH AND TELEPHONE TECHNICIANS.

HELD AT BUDA-PEST, SEPTEMBER, 1908.

Special Reports and Summaries by T. F. PURVES *and* J. G. HILL.

THE institution of an International Technical Conference of Government Telegraph and Telephone Engineers is the fruit of suggestions made by the Hungarian and French representatives at the General International Telegraph Conference of London in 1904. In January of this year those proposals were revived and developed by the Hungarian administration. It is thus appropriate that the first Conference should have been held at Buda-Pest, and the officials there are to be warmly congratulated upon the indisputable success which has attended their efforts.

The names of the delegates who attended the Conference appeared in the official list as follows:

AUSTRIA.—M. Karl Barth von Wehrenalp, Conseiller aulique, Chef de la Section technique; M. H. G. Dietl, Conseiller supérieur technique; M. Franz Patlewicz, Conseiller supérieur technique; M. M. O. Filepek, Conseiller technique; M. Wladislaw Gadomski, Conseiller technique; M. Karl Hansel, Conseiller technique; M. A. Šandor, Conseiller technique; M. Anton Stegu, Conseiller technique; M. Karl Havelik, Commissaire supérieur technique; M. Rudolf Knabe, Commissaire technique; M. Franz Stecher von Sebenitz, Commissaire supérieur technique; M. Mate Ivčevič, Ingénieur, Élève de construction.

BULGARIA.—M. M. Rousseff, Chef de la Section technique.

DENMARK.—M. C. E. Krarup, Chef du Département des Télégraphes.

FRANCE.—M. Estaunié, Directeur du Matériel et de la Construction; M. A. Dennery, Ingénieur-en-chef des Postes et Télé-

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graphes, Directeur du Cabinet du Sous-Secrétaire d'État; M. Bazille, Ingénieur-en-chef, chef de Bureau.

GERMANY.—M. le Professeur Dr. Strecker, Conseiller intime supérieur des Postes; M. A. Kraatz, Ingénieur des Télégraphes; M. F. Gutzmann, Ingénieur des Télégraphes; M. Th. M. Barthel, Secrétaire des Télégraphes; M. Gebhard, Conseiller impérial, Directeur des Télégraphes; M. E. Günther, Élève de Construction supérieur; M. W. Herz, Inspecteur des Télégraphes; M. Müller, Inspecteur supérieur des Postes; M. Ritter (Württemberg), Conseiller technique; M. F. Stegmann (Bavière), Conseiller des Postes; M. H. K. Steidle (Bavière), Adjoint supérieur des Postes; M. E. Wittichen, Ingénieur des Télégraphes.

GREAT BRITAIN.—Major W. A. J. O'Meara, C.M.G., R.E. Engineer-in-Chief; Mr. T. F. Purves, Staff Engineer; Mr. J. G. Hill, Engineer.

HOLLAND.—M. A. E. R. Collette, Ingénieur-en-chef des Télégraphes et Téléphones d'État, Directeur du service technique; M. F. C. Proper, Chef des Matériaux des Télégraphes et Téléphones d'État.

HUNGARY.—M. André Kolossváry, Premier Directeur technique, Chef du service technique; M. Joseph Váter, Directeur technique; M. Paul Balla, Conseiller technique; M. Frédéric Schaden, Conseiller technique; M. Joseph Hollós, Conseiller technique; M. Étienne Bayler, Conseiller technique; M. Edmond Ratkovszky, Conseiller technique; M. Charles Holzmann, Conseiller technique; M. Jules Burzogany, Ingénieur supérieur; M. Leopold Lazar, Ingénieur supérieur; M. Julien Fodor, Ingénieur supérieur; M. Bernard Paskay, Ingénieur supérieur; M. Béla Gati, Ingénieur supérieur; M. Samuel Haltenberger, Ingénieur supérieur; M. Eugéne Rédl, Ingénieur; M. Béla Julcher, Ingénieur; M. Ernest Berdenich, Ingénieur; M. Charles Kisfalndy, Ingénieur; M. Denis Cimponeriu, Second Ingénieur; M. Dezső Véghely, Second Ingénieur; M. Ernest Zerneck, Second Ingénieur; M. Josef Kuchejda, Second Ingénieur; M. Ladislas de Komarnicki, Second Ingénieur; M. Augustin Maior, Second Ingénieur; M. Eugéne Fritz, Second Ingénieur.

ITALY.—M. le Professeur Giovanni di Pirro, Chef de Section dans l'Institut supérieur postal-télégraphique; M. Salvatore Montinari, Secrétaire chez la Direction Générale des Télégraphes; M. le Docteur Enrico Mirabelli, Inspecteur central technique.

ROUMANIA.—M. Georges M. Radacovitch, Ingénieur, Chef de la Division technique; M. Carol J. Vidic, Ingénieur des Télégraphes; M. A. Marini, Ingénieur des Télégraphes.

RUSSIA.—M. Balthazar Evangoulow, Ingénieur Électricien, Chef de la Division technique.

SERVIA.—M. Jacques Petrovitch, Chef de Section; M. Milan

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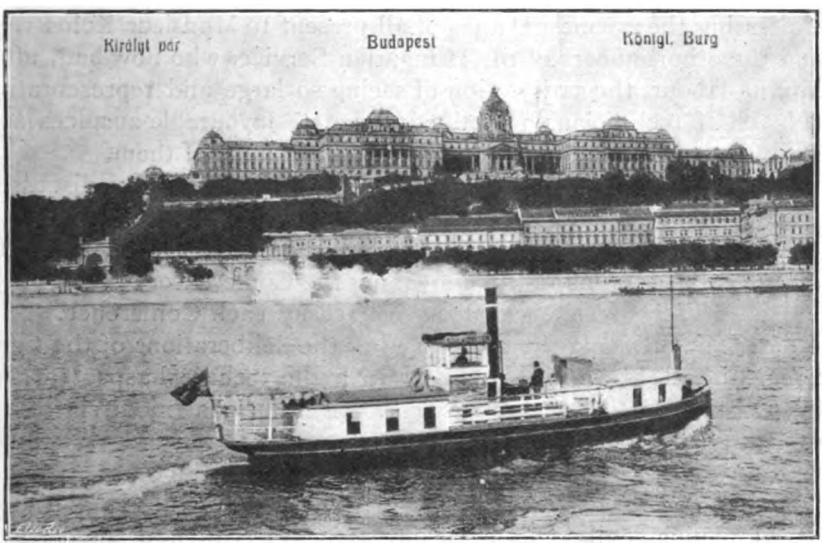
Georgevitch, Chef de Section; M. Kosta Dantchevitch, Chef de Section.

SWEDEN.—M. Axel Rydin, Chef de la Division technique à la Direction des Télégraphes; M. Axel Hultman, Directeur des Téléphones d'État.

TURKEY.—M. Hassan Férid, Directeur de la Fabrique; M. Mehmed Emin, Sous-Chef du Bureau des Ingénieurs.

The proceedings of the Conference were opened on the afternoon of Monday, September 21st, at a reception of the delegates by the Hungarian Committee in the rooms generously placed at their



I.—THE ROYAL PALACE OF BUDA.

disposal by the Hungarian Society of Engineers and Architects. The same evening the Society of Engineers and Architects held a reception of the delegates in the Conference Chambers.

The inaugural sitting took place on the following morning in the large hall of the Society. Monsieur Kolossváry, the President, briefly welcomed the delegates. He thanked the various administrations for the facilities they had granted for the attendance of their representatives, and for the moral and material support which they had accorded to the Conference. He dwelt upon the far-reaching results that might be expected to attend the labours of such an assembly, and on the advantages of friendship and co-operation on the part of those who are working towards common ends. Reviewing the objects and scope of the Conference, he indicated the lines on which

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its discussions could most usefully proceed, and expressed his hope that the new form of activity that day inaugurated might achieve results of importance to the progress of humanity. It was his sad duty to allude to a disaster which had unfortunately deprived the Conference of the attendance of the three French delegates, namely, the total destruction by fire of the great Central Telephone Exchange in the Rue Gutenburg, Paris. At that moment the French delegates were on their way back to Paris at the urgent call of their administration. He was sure that the whole Conference would concur in the proposal that a telegram, expressive of their deep sympathy, should be despatched to the French authorities. (Applause.) He now declared the Conference open. (Applause.)

Dr. Strecker (Berlin) responded to the presidential address, expressing the warmest thanks of all present to Monsieur Kolossváry and the other officers of the Hungarian Service, who now had, after infinite labour, the satisfaction of seeing so large and representative a body of technicians assembled under so favourable auspices and ready to undertake the labours which lay in front of them.

The standing regulations of the Conference were then discussed and adopted. The following points were included:

(1) The President of the Conference shall be the senior technical officer of the administration convoking the Conference.

(2) A Vice-President shall be elected by each Conference.

(3) The only questions admitted to the deliberations of the Conference shall be those associated with the technical aspect of the telegraph and telephone services. Resolutions modifying this regulation are not in order.

(4) A Bureau shall be elected at the first sitting, and shall be responsible for the preparation and issue of a *procès-verbal* of each sitting, which shall contain the title of each lecture and the debates thereon. The full text of the lectures shall appear as an appendix to the *procès-verbal*.

Thereafter Major O'Meara was unanimously elected to the position of Vice-President, and the Bureau was elected and constituted as follows:

Chief.—M. Hollós.

Editors.—M. Gutzmann, M. Sandor, M. Hill, M. Mirabelli, M. Vidic, M. Fodor, M. de Komarnicki.

It was resolved that the sittings should commence at 9.30 a.m., and should be continued as late as the programme of visits and inspections for each afternoon would allow. The grouping of lectures and discussions for each day was settled. In the afternoon a visit was paid to the Central Telegraph Office, a stately building with abundant light and air in all its parts. Among the noteworthy features of this installation mention may be made of the method by

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which the current required for working the telegraph system is supplied. There are no primary or secondary batteries, but a motor-driven generator discharges continuously across a bank of lamps with "earth" in the centre. Positive and negative voltages up to 250 volts by steps of 25 volts are supplied to the instrument room by means of taps taken from suitable points in the discharge circuit. A further feature of special interest to the British delegates was a large intercommunication switch, the construction of which has been, to a great extent, modelled on that recently installed in the London Central Telegraph Office. In the evening the delegates were entertained to dinner by the Hungarian Administration of Posts and Telegraphs. Monsieur de Kossuth, Minister of Commerce,

2.—Elizabeth Bridge and Left Bank of Danube.

presided, and proposed the health of the delegates and the success of the Conference. Major O'Meara responded and gave the toast of Hungary.

Wednesday, September 23rd.—Major O'Meara presided, and read telegrams of good wishes received from various administrations.

The following lectures were delivered and discussed:

M. Krarup (Denmark).—"The Use of Subterranean and Submarine Cables for Telephonic Purposes."

Dr. Mirabelli (Italy).—"Methods of Overcoming Disturbances of Telegraph Working Caused by Electrical Traction Systems."

Major O'Meara (Great Britain).—"The Main Telegraph Cable System of the British Isles."

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M. Bazille (France).—"Types of Subterranean Cables employed in France" (given by M. Hollós in M. Bazille's absence).

In the afternoon a visit was paid to the works of the "Societé Anonyme des Constructions Electriques," at Ujpest, where the manufacture of telephonic apparatus and of carbon and metallic filament lamps was inspected in detail.

Thursday, September 24th: communications read and discussed:

Dr. Strecker (Germany).—"The Provision of Current for Telegraph and Telephone Purposes by means of Secondary Batteries."

M. Barth (Austria).—"Discussion of the Relative Merits of Manual and Automatic Exchanges for Telephonic Service."

M. Steidle (Germany).—"Fundamental Technical Data and Economic Results of Semi-automatic Telephone Exchange Working in Town and Country Districts."

In the afternoon an opportunity was afforded for detailed explanation and examination of illustrative working models of the automatic and semi-automatic exchanges described by MM. Barth and Steidle. Sufficient apparatus to demonstrate fully the action of both systems had been installed in the Telephone Exchange building, and was the object of much interest. The local and trunk exchanges were also inspected in detail. The former serves the whole city of Buda-Pest, and is situated in a large and fine hall. The switchboard, which was constructed by the Western Electric Co., is one of the largest ever made, and has accommodation for 20,000 subscribers. The jacks are spaced at $\frac{5}{16}$ in. centres, and are, therefore, smaller than any in use in England; the plugs and cords have, of course, to be made on a similarly reduced scale. It was stated that, in spite of the smallness of these parts, maintenance gives no special trouble, and the number of faults on the switchboards is not in any way abnormal. The leading in of the underground cables, the protective and distributing appliances, etc., are all on a very large scale and thoroughly up-to-date. The accommodation of the Trunk Exchange is strikingly inferior to that of the local central. It is situated in a small and very congested room, but it should be mentioned that arrangements are already in progress for the construction of a new and separate trunk exchange. It is a point of interest that the new trunk exchange building will be situated *outside* the city. It will thus be possible to bring all the trunk circuits up to the exchange by means of open routes. A great number of through trunk connections are effected at Buda-Pest, and the speaking efficiency of the service will thus be greatly increased by the avoidance of underground work. Communication between the trunk and local exchanges will, of course, have to be afforded by underground cables.

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Friday, September 25th: On this day the Conference did not sit, but the whole of the delegates were conveyed by special train to Püspökladány, where the Hungarian administration has recently established impregnation plant for creosoting telegraph poles. Until recently untreated timber was used exclusively. The impregnating works at Püspökladány are situated on the main eastern line of railway about 180 miles from Buda-Pest at a convenient distributing point. An extensive study of creosoting methods was made before the plant was erected, and the whole, including the arrangements for handling and stacking the timber, is exceedingly up-to-date and efficient. Native Hungarian timber is exclusively used.

Saturday, September 26th: Communications delivered and discussed:

Mr. Purves (Great Britain).—"Telegraph Intercommunication and Concentration Switching, and the Applications of the Central Battery System to Telegraph Working."

Prof. di Pirro (Italy).—"The Impedance of Non-uniform Telephone Circuits."

M. Bela Gati (Hungary). — "The Measurement of Line Constants by means of the Barretter."

M. Hill (Great Britain).—"Practical Applications of the Laws of Telephone Transmission."

Afternoon: Visits of inspection to generating station of "Societé Anonyme pour Courant Continu." Three-phase current at 2000 volts, transformed to 115 volts, continuous, in several sub-stations throughout the city for electric light and power purposes. Generating station of "Societé Anonyme Hongrois," 3000 volts alternating transformed to 150 volts alternating in sub-stations; also 5000 volts alternating transformed in sub-stations to 550 volts continuous. Second power station for tramway service, overhead trolley system; fine station in course of construction, several steam turbines of 2000 horse-power being installed.

Sunday, September 27th: Visited State Polytechnic under guidance of Prof. Zipernowsky; a large and splendidly equipped educational institution which deals with, and grants diplomas in, all branches of electrical engineering.

Monday, September 28th: Continuation of discussion of papers presented by Prof. di Pirro, M. Bela Gati and Mr. Hill.

New papers read and discussed:

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M. Gutzmann (Germany).—" Systems of Party Lines serving several Telephone Stations."

M. Hollós (Hungary).—" Cutting Out of Circuit of Intermediate Offices on Long Trunk Lines during Conversation."

Afternoon: Visit to the works of Messrs. Manfred Weiss; rolling of copper sheets and tubes, wire drawing, mauufacture of shells, cartridges, etc.

Tuesday, September 29th: Papers read and discussed:

M. Kraatz (Germany).—" Machine and Multiplex Telegraph Systems," and discussion of circumstances in which they should be used.

M. Bazille (France).—" Superimposed Telephone Working"; " Baudot Telegraph System" (given by M. Hollós in M. Bazille's absence).

M. Hollós (Hungary).—" Comparative Results of New Telegraph Systems."

M. Montinari (Italy).—" Improvements in Apparatus for Closed Circuit Telegraph Working."

M. Hultmann (Sweden).—" The Common Battery Telephone System as used in Sweden,

Afternoon: Closing sitting. MM. Barth and Strecker proposed the formation of a committee for the regulation of the next Conference. After an animated discussion the following resolutions were unanimously carried.

(1) The International Conference of Telegraph Technicians at Buda-Pest, 1908, institutes a committee for the management of the next Conference.

(2) The place of meeting of the Committee is Buda-Pest.

(3) The Committee shall consist of one member of each administration represented at this Conference, elected by the votes of the whole Conference; the Hungarian administration shall be represented by three members elected by the whole Conference from among the Hungarian delegates.

(4) The Committee may co-opt additional members by the vote of the majority. Such additional members must be technical officials of superior rank in a State administration, and must be proposed by the officials of two other administrations already serving on the Committee. Election must be by a majority of not less than two thirds of the votes cast.

(5) The Hungarian members of the Committee form an executive sub-committee. The President of the Committee shall be elected by the Conference and shall direct the sub-committee.

(6) The elections shall hold good until the next Conference.

(7) The Conference shall prescribe to the Committee certain

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subjects to be studied, and the Committee shall designate at least two of its members to deal specially with each subject, and prepare it for treatment at the next Conference.

(8) The Committee has the right to choose additional subjects for study and to prepare them for treatment. Such subjects must be approved by at least half the members of the Committee.

The following members of Committee were then elected:

Hungary.—M. Kolossváry (President). Austria.—M. Karl Barth von Wehrenalp. Bavaria.—M. Stegmann. Bulgaria.—M. Rousseff. Denmark.—M. Krarup. France.—M. Estaunié. Germany.—Dr. Strecker. Great Britain.—Major O'Meara. Holland.—M. Collette. Hungary.—M. Vater, M. Hollós. Italy.—Dr. Mirabelli. Roumania. —M. Radacovitch. Russia.—M. Evangoulow. Servia.—M. Petrovitch. Sweden.—M. Rydin. Turkey.—M. Ferid. Württemberg.—M. Ritter.

After election the Committee unanimously co-opted as additional members: Prof. di Pirro (Italy), and M. Breisig (Germany).

The Conference referred to the Committee as subjects for special study:

(1) Automatic *versus* manual telephone exchanges.

(2) To fix the electrical constants of an international standard cable for telephone transmission measurements.

(3) The best means of avoiding damage or interference to telegraph and telephone circuits by power circuits.

It was then decided that the next Conference should be held in 1910. On the motion of the President the locality of the Conference was not fixed, it being thought advisable to leave this point to the Committee, in view of the possibility that invitations might be received from administrations interested in the matter. It was decided that the locality should be announced at least six months before the date of opening the Conference.

The President then addressed the Conference as follows:

"Gentlemen, we have arrived at the termination of our first Conference. If we now cast a backward glance upon its labours I am sure that we must each feel entitled to return to our homes with head erect and mind composed. Our work has been serious, and we may well hope that it will serve as a base for manifold future activities. If we add to that the sentiments of mutual respect and cordiality that we have seen developed during its course, I think, gentlemen, that we may look ahead with feelings of full assurance and satisfaction.

"When the fruits borne of your labours here become apparent I am sure, gentlemen, that each of you will be proud of the part he has played and will regard with pleasure the results of his efforts. Before saying farewell, which I cannot do without emotion, permit

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me to thank you all once again for the hearty collaboration and the strenuous goodwill which you have so ungrudgingly devoted to the purposes of our assembly. Above all I thank you for having demonstrated, by the striking success of this conference, the utility and the vitality of the enterprise which we have undertaken.

" In returning to your own countries, I trust that you will retain in full the feelings of friendship which our intercourse has engendered; this friendship and unanimity will be the best and surest pledge of the fertility of our future labour and progress. In the hope of many future meetings, gentlemen, I now declare our first Conference at an end." (Prolonged applause.)

On the motion of Dr. Strecker the unanimous thanks and gratitude of the delegates towards Monsieur Kolossváry were enthusiastically expressed.

Monsieur Barth thanked in turn Major O'Meara, Monsieur Collette, and Monsieur Hollós, whose efforts had so powerfully contributed to the success of the meetings.

Monsieur Dietl expressed the thanks of the delegates to Monsieur Vidic, who from the first inception of the idea had never ceased to work unsparingly in the interest of securing a happy and successful issue to the Conference.

The proceedings then terminated.

In the evening the delegates attended a farewell dinner given to the Conference by Monsieur de Kossuth, Minister of Commerce.

SUMMARIES OF LECTURES.

THE USE OF SUBTERRANEAN AND SUBMARINE CABLES FOR TELEPHONIC PURPOSES.

By C. E. KRARUP, Copenhagen.

The author points out that the limits of speech on telephone cables of the ordinary air-space type is defined. It is pointed out that these limits are soon reached, but that by the insertion of Pupin coils in such cables the range is very much extended. The author, however, considers that the use of loading coils in large towns where composite cables for widely differing types of telephone circuits are used, involves such complexity in calculation that a cable designed by himself and described in the " Journal Télégraphique " for June, 1905, would be preferable. This cable consists of copper wires having wound around them one or more layers of fine oxidised soft iron wire. The inductance thus obtained is four or five times that of the untreated copper wire in cables, but it is not so great as can be obtained by the use of

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Pupin coils. The capacity of an iron-wound cable for alternating currents is less than that for continuous currents. M. Krarup claims that such cables can be used without considering the complex factors necessary with loaded cables, and that therefore in their use lies the real solution of the difficulty in large towns. If, however, the difficulties in calculating Pupin coils could be overcome, cables containing them would be of great use in future *in the case of wires of similar dimensions.* The ideal cable is one having distributed self-induction, but in much greater quantity than that given by present iron-wound cables. Iron-wound underground cables are in use in numerous towns in Denmark and also in some Swedish towns, and some submarine cables are also so treated. Another cable of the same type is being laid at Baku, in the Caucasus.

The details of the latest type of cable are as follows: 4 × 4 + 12 × 2 conductors; 2 mm² (1·6 mm.) copper; 8·7 ohms per km. for continuous current, 0·37 mm. iron wire. Insulation air-space paper 0·12 mf. wire to earth, 0·06 wire to wire per km. Effective $\beta = 0{\cdot}0165$ at a frequency of 940 periods calculated (actually less). Therefore, speaking distance without difficulty 120 to 160 km. (calculated). Price, June, 1908, 555fr. per 100 m. with double-wire armour.

Discussion on M. Krarup's Paper.

M. de Pirro (Rome) recognised the advantage of M. Krarup's cable over those of the ordinary type, but showed by a mathematical example that with an increase of only seven times the ordinary inductance of the cable due to the iron wire wound upon it as claimed by M. Krarup for his cable, the augmentation in efficiency which would follow if the losses in the iron were taken into account could not be greater than 15 per cent.

M. Steidle (Munich) observed that the formula $\frac{R}{2}\sqrt{\frac{C}{L}}$ to be valid depends upon the relation $\frac{R^2}{P^2 L^2} < 1$, and with the comparatively small increase in L in iron-wound cable, a small R should be aimed at.

Dr. Strecker (Berlin) said that the Cuxhaven–Heligoland cable (70 km.) gave good service when extended by open lines 400 km. in length to Berlin.

M. Béla Gáti (Buda-Pest) said he had found some air-space cables to have an insulation resistance of 28,000ω per km. at telephonic frequencies, and suggested that the diminution of capacity with alternating currents was common to all types of cable. He asked whether β was measured or calculated, and whether the cable was suitable for telegraphic purposes.

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M. Krarup, in reply to M. de Pirro, said that the theoretical calculation given did not agree with observed facts as the speaking distance of his cable is three or four times that of ordinary cable. In reply to M. Gáti, he said that β was calculated from R, C, and L, and proved by the method of measurement adopted by Dr. Breisig. The cable had no special advantage for telegraph working, except in the case of high-speed automatic systems.

Note on M. Krarup's Paper.

M. Krarup seems to be under the impression that the calculation of efficiency of transmission in loaded cables is very difficult, if not sometimes impracticable, whereas in practice relatively simple formulæ have recently been developed, which render it a fairly easy matter. The real point at issue is the relative efficiency of speech transmission of the two types of cable in question. If this were known it would be a simple matter to weigh the advantages and disadvantages of the two types of cable from all other points of view. Although the exact efficiency of loaded cables is now well known in some countries, this, curiously enough, does not appear to be the case with iron-wound cables. Much ink has been spilt on the question of the exact value which should be assigned to them by calculation, but a practical test by the standard cable method does not yet appear to have been made, although it would settle the matter definitely.

METHODS OF OVERCOMING DISTURBANCES OF TELEGRAPH WORKING CAUSED BY ELECTRICAL TRACTION SYSTEMS.

By Dr. E. Mirabelli, Rome.

The author gives details showing the rapid increase of electrical traction systems, and proceeds to describe disturbances of telegraphic circuits experienced in the neighbourhood of such systems in Italy. He has conducted special experiments in connection with circuits following the route of the Valtelina Electric Railway between Lecco and Chiavenna, a distance of 110 kilomètres. The power transmission is three-phase at 15,000 volts, and the conductors follow closely the route of the railway. Ten sub-stations are placed at intervals of about 10 km., and in these the current is transformed to 3000 volts, three-phase, and fed to the electric trains by two conductors 90 centimètres apart, the rails constituting the third conductor. Generally the same supports carry both the primary and secondary power circuits.

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He mentions also another railway—Milan to Porto Ceresio—with three-phase transmission at 13,000 volts transformed to 650 volts continuous for the train service, which is fed by a central rail. The three-phase supply mains follow the line at a distance of 10 to 30 mètres. This system has caused no disturbance to the telegraph circuits which run alongside the railway.

Several experiments with the circuits adjacent to the Valtelina Railway are described in detail. The main disturbance was found to be due to induction from the two service conductors forming elements of the 3000 volt secondary three-phase system fed to the trains. There was little disturbance due to leakage, except when heavy trains were running in positions close to the sub-stations. Differences of earth potential exceeding 5 volts between sub-stations were noted. The total interference rendered telegraphic communication quite impossible, and the only practicable cure was to double the wires for the whole length adjacent to the railway, and insert a repeater at each end. Even then the insulation of the lines had to be very carefully maintained to avoid disturbance. Trials of closed circuit working with fairly high current were therefore made, and found to ameliorate the conditions considerably. It was, in fact, found possible to withdraw the repeaters at one end, and simply to earth the second wire at that point. The circuits are now working in this way with fair success.

The alternatives suggested for further trial and consideration are:

(1) The application of condensers and inductive resistances in the telegraph circuits in order to separate the currents of different natures.

(2) Doubling the aërial telegraphic wires wholly or in part.

(3) Laying underground cables along the railway for loop working.

(4) Arranging that power services shall use continuous current at low voltage in the secondary circuits or three-phase secondary currents, fed to the motors by symmetrically placed conductors.

The Italian administration is continuing experiments on the subject.

In the ensuing discussion Prof. di Pirro (Rome), laid down the lines on which such investigations might most profitably be conducted. He hoped to be able to furnish the next Conference with the results of his personal experiments and deductions.

Monsieur Barth (Vienna) and Dr. Strecker (Berlin) dwelt upon the importance of the matter, and proposed that it should be one of the subjects referred to the Committee for special study and fuller discussion at the next Conference. This was agreed to.

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THE MAIN TELEGRAPH CABLE SYSTEM OF THE BRITISH ISLES.

By MAJOR W. A. J. O'MEARA, C.M.G., R.E., London.

Major O'Meara gave a historical sketch of the development of underground telegraph cable working in Great Britain from the earliest days to the present time, and presented the interesting plans shown in **1** and **2**.

Financial, engineering, and traffic statistics with reference to the projects now in course of execution were furnished, together with

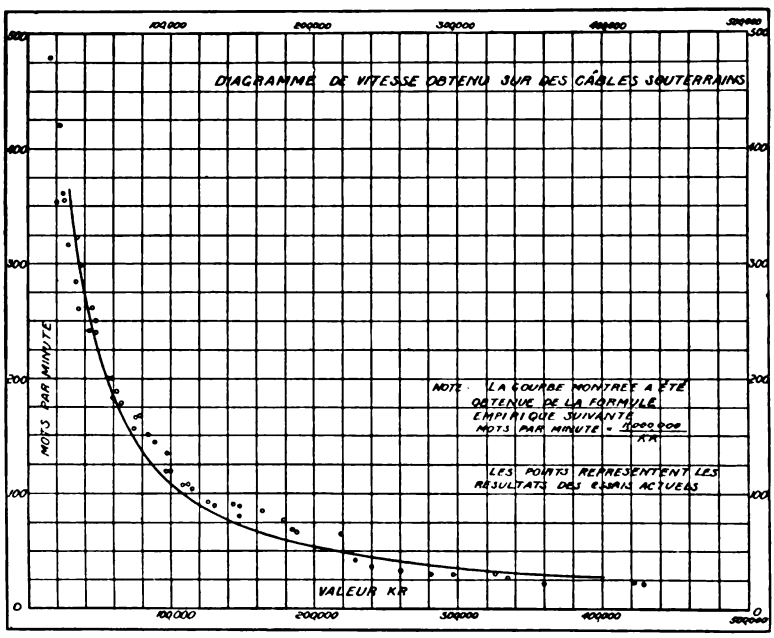
DIAGRAMME DE VITESSE OBTENU SUR DES CÂBLES SOUTERRAINS
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NOTE LA COURBE MONTRE A ÉTÉ OBTENUE DE LA FORMULE EMPIRIQUE SUIVANTE
LES POINTS REPRESENTENT LES RESULTATS DES ESSAIS ACTUELS

22.—CURVE SHOWING SPEEDS OBTAINABLE ON SUBMARINE CABLES.

complete descriptions of the materials used, the methods of planning and organising the work, the operations of trenching, constructing man-holes and joint-boxes, erecting test-pillars, cable laying, jointing and testing. The various types of cable utilised, composite and otherwise, were fully described and illustrated, together with tools and special appliances. Schedules of faults were appended, giving their nature and cause and the methods of dealing with them. The methods of eliminating inductive disturbances from wire to wire and of connecting the conductors for loop and superimposed working were also exhaustively treated. Working speeds were analysed and illustrated by the curve shown in **22**, which is here reproduced.

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2.—1908. Underground System now Existing and in Course of Construction. Dotted lines show Routes in Course of Construction.

1.—The Complete Project for an Underground Telegraph Cable System in the British Isles, prepared in 1881. (The figures indicate the Number of Wires proposed for each Section.)

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In the ensuing discussion Monsieur Hollós and others warmly thanked Major O'Meara for having placed at the disposal of the administrations represented at the Conference so great a mass of information of the highest practical value. All were aware that large schemes of trunk cable laying were in progress in England, and, thanks to the careful and exhaustive manner in which particulars had been placed before them, they were now in a position to take full advantage of the extensive and unique experience of the British administration in connection with this subject.

TYPES OF SUBTERRANEAN CABLES EMPLOYED IN FRANCE.

By M. BAZILLE, Paris.

The first subterranean lines in France were constructed in 1845, and were insulated by means of vulcanised rubber. In 1855 bare wires laid in bitumen were used, but without much success. Gutta percha continued to be used, although many efforts were made to supersede it on account of its high cost, until 1890 when the first paper cables were introduced into France.

Monsieur Bazille gives mechanical and electrical data regarding gutta-percha cables, including a specification for the G.P. and a statement of the tests applied to the cables. He discusses the relative advantages and disadvantages of lead-covered paper-insulated cables, and gives schedules showing full details of the principal types which have been made and used for the French administration. He describes the tests which the paper should pass, the method of laying up, and the electrical testing of the completed cables. Methods of jointing are then touched upon and the desiccation of cables is dealt with. He also describes the usual methods of distributing telephone cables in France. Cables of "pair"-formation are exclusively used; the conductors of telegraphic cables have a uniform diameter of 2 millimètres.

Long subterranean telegraph circuits are worked on metallic loops; M. Bazille has not a high opinion of screened conductors. For telephone exchange purposes the cable conductors have a uniform diameter of 1 millimètre both for subscribers' lines and junction lines. This is larger than necessary for short circuits, but uniformity is an advantage. The standard sizes of exchange cables used are 1 pair, 7 pairs, 28 pairs, 56 pairs, 112 pairs, and 224 pairs. Special cables are used for trunk telephone purposes, the conductors having a diameter of 2·5 millimètres. They are only used for leading the circuits into large towns. Short trunk circuits are

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frequently led into towns on the ordinary exchange cables with 1 millimètre conductors.

M. Bazille also treats the subject of the electrolytic action upon the cable sheaths of stray currents from tramway systems. He points out that even when the rails are well bonded the proportion of the current which finds its way back through the soil is seldom less than 12 per cent. or 15 per cent. With badly bonded rails this proportion may easily rise to 60 per cent. An attempt has been made to reduce the currents circulating in the cable-sheaths by interrupting the continuity of the lead covering at intervals. This is done by removing a ring of lead about 1 centimètre in width. The cable is covered at this point by a strip of tarred cloth and is placed in a wooden trough about 3 mètres long, which is then filled up with insulating compound. Experience has shown, however, that this treatment only aggravates the evil by multiplying the points at which the stray currents enter and leave the cable. Attempts have also been made to insulate the cable by enclosing it in a trough filled with compound for the whole length of its passage through dangerous areas. This, too, has been a failure, resulting simply in concentrating the destructive action at or near the points where the cable enters and leaves the trough. A further attempted cure has been to place the whole cable in a metallic sheath so that the latter may carry off all stray currents without permitting them to enter the cable sheath. M. Bazille cites the case of one particular tramway crossing, where a main cable was exposed to very destructive electrolytic influences. About a year ago the cable was therefore insulated, as above, for a distance of about 500 mètres through the danger zone of the crossing. A ring of lead was removed from the sheath near each end of the insulated portion. At each point of leaving the insulation the cable was fitted with a metallic sheath composed of 20 mètres of lead tubing amply soldered around the cable and wrapped thickly with iron wire to ensure good contact with the soil.

Before these sheaths were fitted the difference of potential between the cable (+) and the earth (−) was from 4 to 6 volts; this has practically disappeared since the treatment described above. Further trouble beyond the insulated portion has shown that it will be necessary to extend the insulation to a greater distance in one direction; apart from this the method appears to have effected a satisfactory cure.

Another system tried at another point of rapid deterioration consists in employing a cable, the sheath of which is insulated by a wrapping of paper ·8 millimètres thick surrounded by waterproof canvas and protected by a wrapping of galvanised steel ribbon of the same thickness. The whole is enclosed in moisture-proof braiding.

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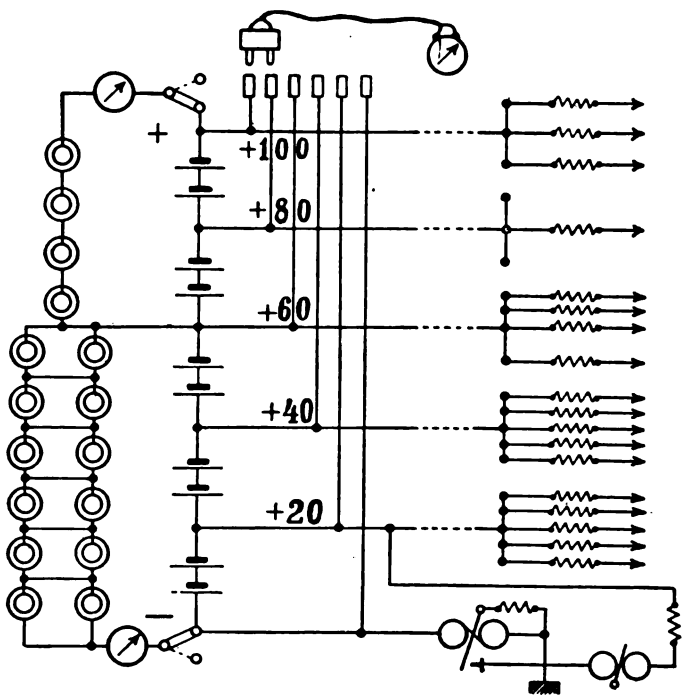
This cable has been in use for a year without showing any signs of deterioration.

THE PROVISION OF CURRENT FOR TELEGRAPH AND TELEPHONE PURPOSES BY MEANS OF SECONDARY BATTERIES.

By Dr. STRECKER, Berlin.

Secondary cells have been used almost exclusively for telegraph purposes in all except the smallest offices in Germany for the past twenty years. For telephone exchange working they were used for eight years before the advent of the Central Battery System, the



I.—ACCUMULATORS CHARGED FROM PRIMARY CELLS.

first installations of which are now about four years old. The telegraph secondary cells in Berlin have worked since 1889 without trouble; no renewals have been required, not even of the plates. But the cells are too large and heavy, and they occupy too much space. Cells of 15 ampère hours capacity are found to be adequate in most offices. The use of primary cells for charging the accumulators, which has always been a feature of the German system at small offices, is described. One thousand primary cells

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used under ordinary conditions on telegraph circuits will deliver on an average only ·002 to ·005 amp. hours per day. If used to charge accumulators they will give easily ·05 a.h. without requiring much more attention. Thus 100 cells can be made to replace 1000, with great saving in space and reduction in labour of maintenance. Current provided in this way costs, however, ten times as much as when taken from power plant; the system is thus suitable only for small offices. Connections are shown in 1. For C.B. telephone purposes in Germany 24 volts are usually employed; sometimes 22 or 20 volts. A reserve set is always provided. Charging current is supplied from a motor generator delivering at about 30 volts. In some cases Koch's converter is used for transforming. In America the cells used are generally much smaller and are charged and worked simultaneously during busy hours. The cells thus have to deliver current only at slack times. The author furnishes detailed data for calculating the size of cells required for telegraph offices of various sizes and for C.B. telephone exchanges on the basis of ascertained average traffic. He then describes the power plant used for charging purposes, and the switching arrangements for altering the grouping of the cells for working and charging. He furnishes details of the cost of all the parts and discusses the economic questions involved in the substitution of secondary for primary cells at telegraph offices, and in connection with telephone exchange systems.

In discussing the paper M. Hollós, Buda-Pest, stated that Dr. Strecker's calculations for C.B. exchanges were exactly in accord with the observed results at the Buda-Pest Central Exchange. A total current of 0·25 amps. is required for each local communication, the average duration of which is found to be three minutes. The battery thus delivers ·25 × 20 × $\frac{3}{60}$ = 0·25 Watt-hours, which is exactly the figure given by Dr. Strecker.

AUTOMATIC *versus* MANUAL TELEPHONE EXCHANGES.

By KARL BARTH VON WEHRENALP, Vienna.

M. Barth favours the automatic system, which is now being tried in Austria, and which he described and illustrated by means of a small working installation.

He, however, points out that a service exclusively automatic is impracticable, and he would employ manual operators for trunk service, for information service, transmission of telegrams, private branch exchanges, and, in general, wherever the method of operating does not conform to that of ordinary subscribers' circuits.

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In the Austrian system, which is a modification of the Strowger system, every subscriber is provided with a special key which permits of a small manual exchange being called in the same building as the automatic exchange in case of failure of the automatic system. The attention of a called subscriber is obtained by the calling subscriber automatically in ten seconds, and, allowing three seconds for setting the figures on the telephone, a total of thirteen seconds is arrived at. At present M. Barth considers the time on the manual system in Europe to be half a minute! A 200-line automatic exchange in Vienna is found to work well, and little maintenance is required. The system will in the near future be largely extended.

M. Barth's conclusions are as follows:

(1) The Automatic Telephone System, if good apparatus is used, would give a more rapid and reliable service than a manual system.

(2) In large exchanges (over 10,000 subscribers) considerable economy would result from its use, and it would, moreover, render possible larger exchanges than could be installed on the manual system.

(3) For exchanges having between 500 and 1000 subscribers the automatic system should also be considered favourably from the point of view of its technical advantages, and for the reason that it permits of the growth, step by step, of central exchanges according to the needs of the Service. On the other hand the manual system is not nearly so elastic, and the enlargement of such exchanges in many cases involves monetary loss.

(4) In exchanges having less than 500 subscribers the automatic system is in general dearer than the manual system. It can only be recommended in those cases where quick and reliable working are considered to be the principal features of the problem.

Discussion on M. Barth's Paper.

Major O'Meara thanked M. Barth for his paper. He asked for information on the following points:

(1) The necessary dimensions for the automatic installation.

(2) The wages of the mechanics employed for the maintenance of the apparatus in these offices.

(3) The price of subscribers' sets for the automatic system.

M. Hultmann (Stockholm) said that small automatic exchanges for rural use had been used in Sweden for some years, generally with satisfactory results. He was of opinion, however, that the automatic system would in time give rise to complaint owing to the dislike on the part of subscribers to the performance of manual operations, and they would wish to return to the simpler method of operation. Notwithstanding this, however, he thought there was undoubtedly a future field for the automatic exchange.

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M. Stegmann (Munich) thought the introduction of the automatic system depended more upon economical than technical conditions. The difficulty, in his opinion, lay in the possibility of distributing large networks without raising the cost of working.

M. Gutzmann (Berlin) said that the Strowger system installed at Hildesheim gave every satisfaction.

M. Hollós (Budapest) remarked that it would have been useful to have a more detailed description of the Austrian automatic system.

M. Steidle (Munich) pointed out that it might be possible to increase the practical capacity of the multiple by arranging for "group-working." Statistics showed that by grouping subscribers (as explained in his paper) a multiple of 10,000 jacks could easily be made to serve 60,000 subscribers.

Dr. Barth, in reply to Major O'Meara, said he had calculated upon 1 mètre square for fifteen subscribers; moreover, not so much light and air were required as in manual exchanges. Operators' wages were calculated at 1200 crowns per annum for large towns (24 crowns = £1), and 1000 crowns for small places. Mechanics are reckoned on 2000 crowns per annum. A subscriber's set costs 120 crowns, but it will be be cheaper when manufactured on a larger scale.

He informed M. Hollós that he would bring full details of the system to the next Conference.

In reply to M. Steidle, M. Barth observed that even supposing that M. Steidle by his excellent system could increase the capacity of a manual exchange from 10,000 to 60,000 or more, still for the very largest exchanges the automatic was the only remedy for the enormous cost of augmenting the Service by means of intermediate exchanges.

Note on M. Barth's Paper.

The "automatic *versus* manual" problem is one of the most absorbing subjects of discussion in the telephone world, and assuredly more will be heard of it in future. The great majority of telephone engineers have, however, up to the present considered that the cost of maintaining the automatic system is out of proportion to the benefit gained, but M. Barth, as the result of Austrian experience, thinks otherwise. The elasticity of an automatic system and its possibilities of large growth are all in its favour, but it should not be overlooked that there is at present a strong opinion in many quarters that the accommodation of more than 10,000 subscribers in one exchange is undesirable.

One wonders to what extent the facilities for obtaining the attention of a manual operator when the automatic fails will in actual practice increase the cost of the service.

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The Austrian Administration is to be congratulated on its enterprise, and the outcome of the development will be looked forward to with interest at the next Conference.

TECHNICAL BASIS AND ECONOMIC RESULTS OF SEMI-AUTOMATIC TELEPHONE EXCHANGE WORKING IN RURAL AND URBAN AREAS.

By H. K. STEIDLE, Munich.

The problem dealt with in this paper is the best method of serving small groups of subscribers situated at some distance from a central exchange. There were a number of cases in Germany where such subscribers were formerly served by direct circuits to a central exchange at some kilometres distance, and the author deals with the advantages to be gained by serving such subscribers by an automatic exchange connected with the nearest manual exchange by a number of junction circuits. The paper deals in detail with methods of determining the number of junction circuits necessary to carry the traffic with any given specified amount of delay ; from this is deduced the most efficient and economical arrangement of junction circuits.

In order to obtain reliable data, an automatic registering apparatus was constructed to record the traffic on each subscriber's line. The details of this apparatus are as follows :

A revolving drum carries a paper register, and in the circuit of each subscriber is a pen actuated by the cut-off relay connection. The cylinder with its paper register revolves at a fixed rate, and normally all the pens make parallel straight lines upon it. During conversation, however, the pen is thrown out of its normal straight line, but makes a mark parallel to it so that the duration of each convervation is recorded.

There is also a recording ammeter in the circuit which gives the sum of all the currents circulating in the subscriber's circuits at any instant, and by the readings of this record the number of subscribers simultaneously engaged can be found.

A large number of records (comprising 100 cases) in different exchanges were taken to obtain *general* results, and from these results a graph was constructed to show what delay would result to a given number of conversations having available for their disposal one, two, three, etc. junction lines. The author finds, on the basis of the traffic figures obtained, that on the supposition that a small group had only twenty conversations per day and one junction circuit the delay would not exceed half a minute, but that if two

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junction circuits were available, instead of one, 100 calls could be disposed of, instead of 20, with the same delay, while with three lines and the same delay only 140 calls could be disposed of.

As a result of these studies the author finds it economical, where possible, to restrict the size of groups in such a way that calls can be satisfactorily disposed of by means of two junction circuits, unless special study shows that construction costs render this arrangement undesirable.

In the system described, each small group connected to a sub-exchange obtains intercommunication automatically, and also by similar means obtains communication over the junction circuits to the nearest central exchange; from that point communication is given by manual operators. The operators have, however, selectors in connection with the junction lines, which enable them to obtain communication with any subscriber in the sub-exchange group.

Note on M. Steidle's Paper.

M. Steidle is to be congratulated upon having presented an interesting paper, quite out of the beaten track. The application of semi-automatic methods to small sub-exchanges certainly appears to have resulted in an improved service, and indeed to have filled in Germany the proverbial "long-felt want." M. Steidle's method of determining the necessary number of junction circuits for traffic of a given magnitude is also novel and ingenious.

CENTRAL BATTERY TELEGRAPH WORKING; TELEGRAPH INTER-COMMUNICATION AND CONCENTRATION SWITCHING.

By T. F. Purves, London.

Mr. Purves discusses the economic reasons in favour of applying the Central Battery System to telegraph circuits, and proceeds to describe in detail the arrangements which the British Post Office has developed in this connection. The first step taken was the installation of the Metropolitan Inter-communication Switching System in the Central Telegraph Office, London. The latest developments of this system are described and illustrated by many carefully arranged diagrams. **3**, **4**, and **6** are reproduced here.

Traffic particulars are given, and the competition of the telephone system is referred to as a factor which has considerably reduced the number of messages circulating from one part of the Metropolis to another. The opinion is, however, expressed that in

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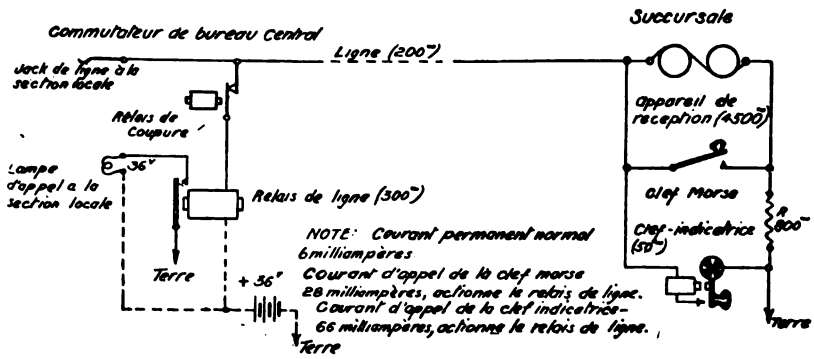
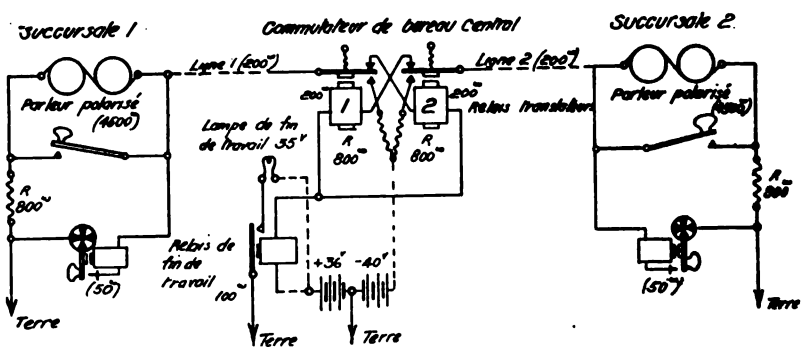
spite of this increasing competition the telegraph system will continue, for many years to come, to be an important and indispensable branch of the system of public communications. The recent extension of the switching system to embrace the various provincial divisions of the C.T.O. is briefly referred to. The system as a whole has allowed more than 12,000 primary cells



3.—Skeleton Connections of an ordinary Inter-communication Circuit.



NOTE:- Courant permanent normal de repos sur chaque ligne - 6 milliampères
- " sur le fil transmetteur - 28 mills - actionne le relais translateur
- " de travail sur le fil receptéur - 6 mills " " parleur polarisé
- "terminé" sur le fil donnant le signal en premier lieu - 66 mills - actionne le relais de fin de travail, le relais translateur et la clef indicatrice
- "terminé" sur le fil donnant le signal en seconde lieu - 38 mills - actionne la clef-indicatrice.

4.—Skeleton Connections of two Circuits Inter-communicating.

to be dispensed with, which in itself represents a maintenance saving of over £1000 per year. The average delay to messages passing across London has been reduced by the inter-communication switch from eighteen minutes to seven minutes. The output of messages per operator per hour has been reduced from twenty-three to eighteen. This is a drawback unavoidably associated with any system which substitutes successive through switchings for the method of dealing with messages in batches over direct wires. The slowing down is,

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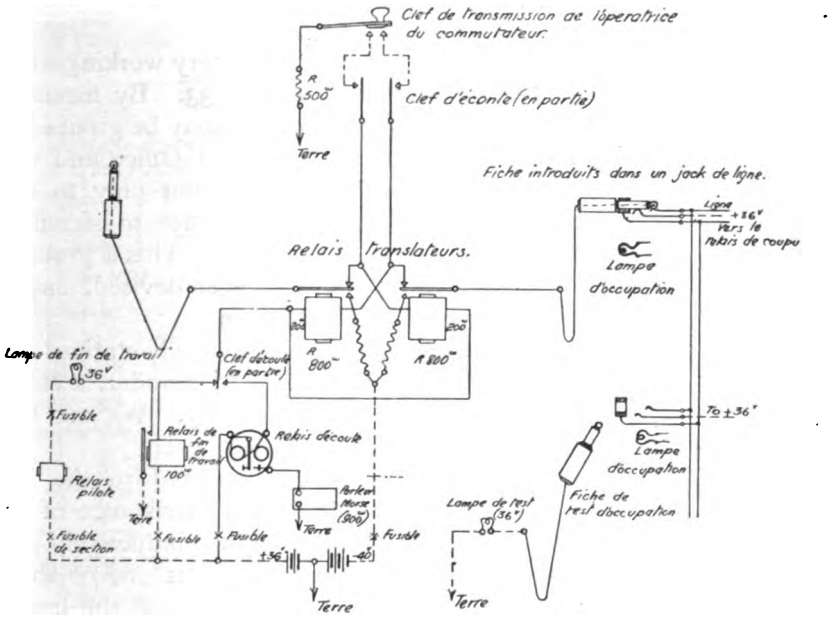
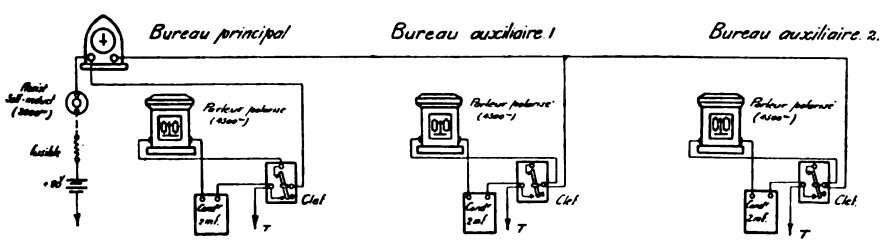
however, much more than compensated for by the saving in re-transmission of London messages at the C.T.O.; this saving amounts to nearly 40,000 transactions a day. Arrangements for the simul-



NOTE Courant permanent normal de repos sur chaque ligne - 6 milliampères.
Courant sur le fil transmetteur - 28 milliampères - actionne le relais translateur.
Courant de travail sur le fil recepteur - 6 milliampères - actionne le parleur polarisé.
Courant sur le fil donnant le signal 'terminé' en premier lieu - 66 milliampères - actionne le relais de fin de travail, le relais translateur, et la Clef-indicatrice.
Courant sur le fil donnant le signal 'terminé' en seconde lieu - 38 milliampères - actionne la Clef-indicatrice.
Courant reçu des succursale dans le relais d'écoute, 28 milliampères.
Courant passant dans le relais d'écoute quand l'opératrice du commutateur actionne sa clef morse 56 milliampères. (28 mills dans chaque relais du translateur.)

6.—Skeleton Connections of Peg and Cord Circuits.



33.—Central Battery System for Omnibus Circuits.

taneous transmission of the 10 a.m. time signal to all London offices through the Inter-communication Switch are described, and several special items of apparatus connected with the system are described and illustrated.

Applications of Central Battery working to ordinary telegraph

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circuits and to circuits on concentrator switches are then described. These include various arrangements for simplex and duplex working. We extract the reference to the recently introduced method of working "Omnibus Circuits" from a central battery.

"Another recent development of Central Battery working which has proved of very great utility is shown by **33**. By means of this system an indefinite number of small offices may be grouped on a line and obtain communication with the Head Office and with each other. In this case condensers are used not only to save consumption of current, but to enable each office to signal by "double current" impulses to all its neighbours. This is probably the simplest double-current telegraph circuit ever devised, and at the same time the cheapest to instal and maintain.

"It will be seen that the apparatus sets at all stations are exactly alike, and consist merely of a polarised sounder, a Morse key, and a condenser of two microfarads capacity. We are now able to obtain these condensers for about 4 francs each."

"A single-pole battery is permanently connected to the line through a resistance which is large relative to the resistance of the line. In practice a coil of 3000 ohms wound inductively and sheathed in iron is used. The battery employed is one of about 80 volts, and the connection between the battery and the line is never broken. When the keys are at rest the line and all the condensers are charged to the full potential of the battery. The only current flowing is that due to insulation loss on the line."

"If a key be depressed at any station the line is connected directly to earth. The potential of the whole line is thus brought approximately to zero, and the condenser at every station discharges itself through the contacts of the particular key which has been depressed. The discharge from each condenser traverses the polarised sounder, to which it is connected, and throws the striker against the 'marking' stop. When the key is allowed to rise the connection between the line and earth is broken, and all the condensers again take up their original charge. The impulse in this case acts in a reverse direction through all the polarised sounders, and throws back the striker of each to the 'spacing' stop."

"On account of the wide range of the polarised sounder, which I have already referred to, the system is workable on lines up to 80 kilomètres in length, and the insulation resistance may fall as low as 2000 ohms without stopping communication."

"This system is being rapidly introduced in England on all circuits which are of suitable character. About half of the work of conversion has been accomplished, and the saving in capital cost already effected is about 500,000 francs, while the estimated

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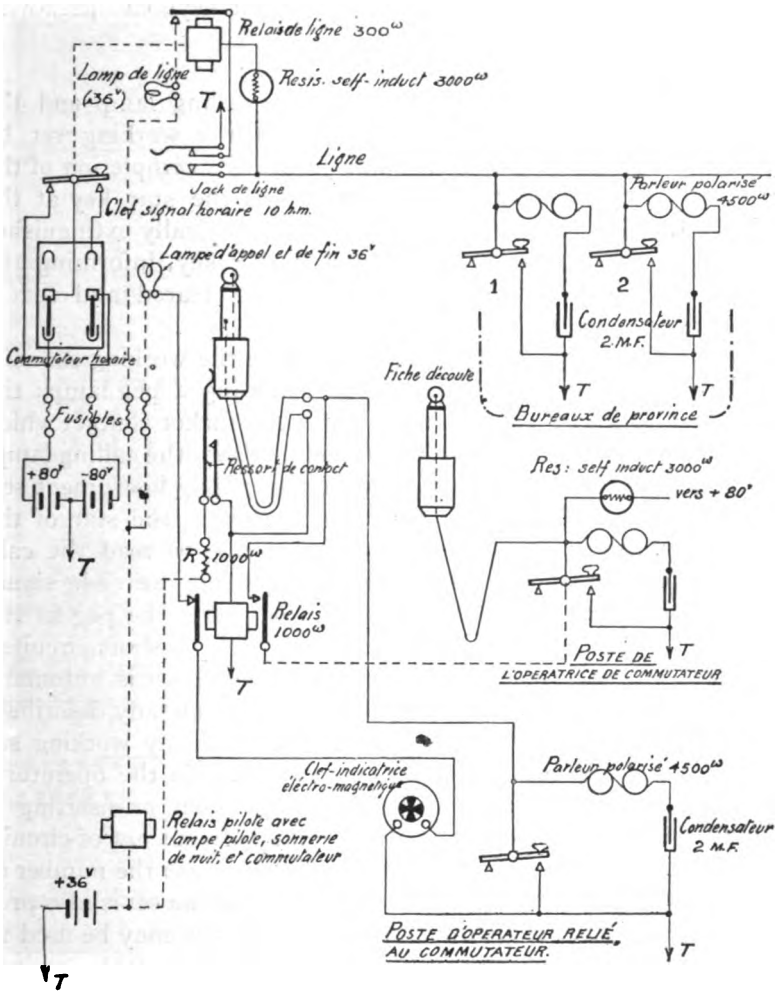
annual saving in maintenance charges is approximately 63,000 francs."

The following is extracted from the section dealing with concentrator switching:

"A proposal is now on foot to establish a concentrator switch



36.—Proposed Connections of Central Battery Concentrator Switch. C.T.O., London.

in the London Central Office capable of accommodating about 150 short provincial lines, most of which serve two or more small offices.

"It is intended to equip all the offices for central battery working, as described. **36** shows in skeleton the proposed connections of the switchboard, etc.

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"Lamp signalling will be adopted, and the switch working sets will be provided with electro-magnetic Indicator Keys for calling and clearing, similar to those used on the inter-communication system.

"The lines will terminate on switch jacks with calling lamps, and the switch working sets will terminate on keyboard pegs with 'calling and clearing' lamps.

"The system of working will be as follows:

"A call from a distant station flashes the calling lamp and the switch operator connects the calling line with a working set by inserting a disengaged peg in the line jack. On completion of the message the clearing lamp is lit by means of the star key at the working set. The withdrawal of the peg automatically extinguishes the lamp and restores the star of the indicator key, informing the working set telegraphist that the line has been cleared and that a fresh call may be made.

"For traffic outwards from the head office the working set calls the switch by means of the indicator key, lighting a peg lamp; the switch operator lifts the peg, thereby closing a socket contact which actuates a double-tongued relay. This extinguishes the calling lamp, joins the switch operator's listening set to the calling instrument set, and informs the calling telegraphist, by restoring the star of the indicator key, that the switch operator is waiting to read the call. The telegraphist at once begins to call by repeating the code signal of the office wanted, and the switch operator inserts the peg in the proper line. By so doing the double-tongued relay is short-circuited (as will be seen from the diagram) and the listening set is automatically cut out of circuit. Clearing is effected as already described. The listening set is thus brought into circuit with any working set only while the corresponding peg is *travelling* (*i. e.* in the operator's hand). On restoring the peg to its normal position, *or* inserting it in any line jack, the listening set is automatically cut out of circuit. This simplicity in operating will considerably increase the number of lines which an operator can attend to. The listening set is also provided with a peg and a signalling key, in order that it may be used to speak on any line when necessary. It is expected that two switch operators will be able to attend to all the lines on this concentrator. It will of course not be necessary to multiple the lines."

As many of our readers are probably not yet familiar with the new form of rotary switch now used for telegraph secondary cell installations, and no detailed description of it has yet appeared, we reproduce a reference to it which occurs towards the end of the paper.

"The main battery sets, supplying 40, 80, and 120 volts, consist of four groups of 20 cells each, and are manipulated by means of a

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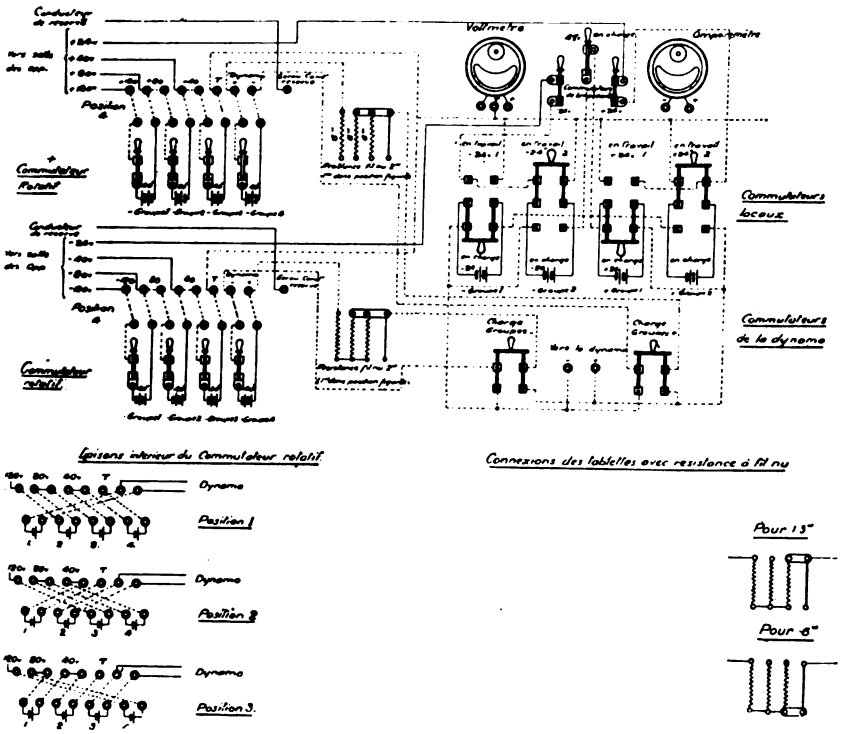
rotary switch specially designed for the purpose. This switch has four positions, and in each position three of the groups of cells are joined up to the working leads, while the fourth is spare and available to be charged. The arrangement of the groups of cells and the connections of the rotary switches in each position are shown on **37**. The connections are interchanged by means of a circular commutator barrel, set with contact rings and blades which engage in suitable fixed brush contacts. This commutator is mounted behind the slate tablet of the switch. The switch is turned by means of a



37.—CONNECTIONS OF SECONDARY CELL-SWITCH CABINET.

removable handle, stop pins being fitted on the side of the switch cabinet to limit the motion of the handle to a quarter of a circle. At some offices the switch is turned every day and at others every two days or three days, according to the period at which the cells require re-charging. The motion of the commutator is continuously in the same direction. When the switch is in position 1 the group of cells marked No. 1 is connected to the dynamo leads for charging; group 2 is supplying the 120-volt power; group 3 is supplying the 80-volt power, and group 4 is supplying the 40-volt power. We will now consider what happens when the switch is turned a quarter of a revolution. The first result is that

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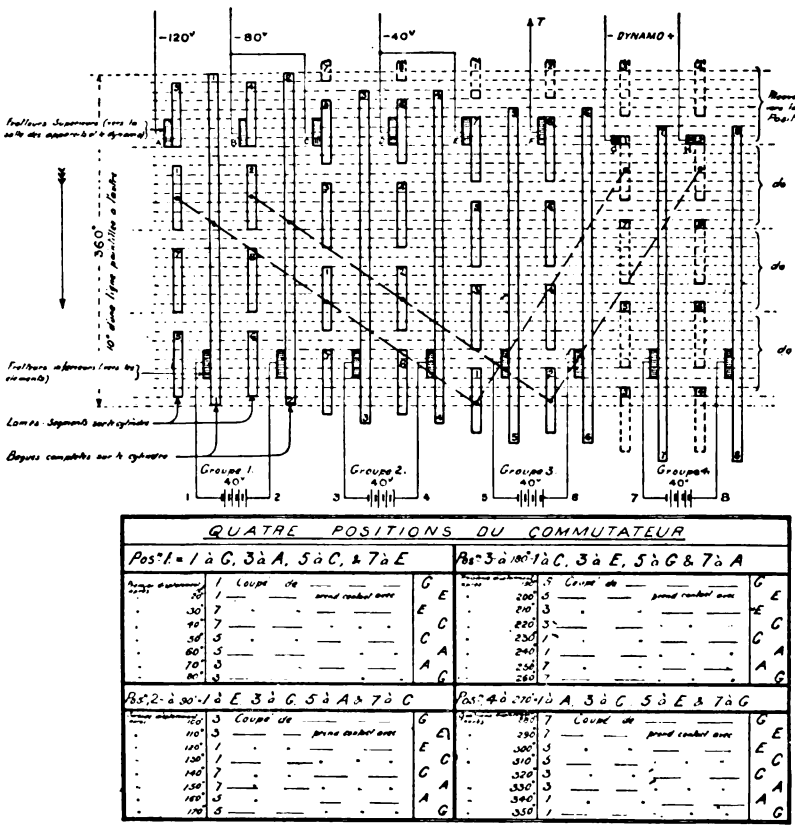
the blades connected to the freshly charged group No. 1 break connection with the brushes on the leads to the charging dynamo. Group 1 is then joined to the brushes of the 40-volt power, where it is in multiple with group 4. An instant later group 4 is cut off from the 40-volt leads and joined in multiple with group 3 on the 80-volt leads. Then group 3 is cut off and joined in multiple with group 2 on the 120-volt leads. Finally group 2 is cut off and connected to the dynamo circuit in readiness to be charged up. **40** shows the


-120v
-80v
-40v
+ DYNAMO -
360°
Groupe 1. 40v
Groupe 2. 40v
Groupe 3 40v
Groupe 4 40v
QUATRE POSITIONS DU COMMUTATEUR
Pos°1 = 1 à C, 3 à A, 5 à C, & 7 à E
Pos°2 à 90° 1 à E 3 à C 5 à A & 7 à C
Pos°3 à 180° 1 à C, 3 à E, 5 à G & 7 à A
Pos°4 à 270° 1 à A 3 à C 5 à E & 7 à G

40.—Connections of Commutator Cylinder. (Blades in Position 1.)

circular commutator barrel unwrapped as a flat surface, and indicates the relative positions of the rings, blades, and brushes. The dynamo brushes, marked "G" and "H," are made only one third the length of the other brushes, and the corresponding blades are shortened to the same lengths at the part where contact is made. This is in order that the dynamo connection to the freshly charged group of cells may be broken at the beginning of the motion of the commutator, and may remain disconnected until the end, when the group of cells thrown spare for charging is finally connected to the dynamo

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brushes. The above description of the successive stages of the movement may appear somewhat complex, but all the changes mentioned take place in a small fraction of a second, while the switch is being turned through a quarter circle. It will be seen that the power is not at any moment cut off from the supply leads to the instrument room, so that the working of the telegraph circuits, even by high-speed systems, is not interfered with in the slighest degree when the secondary cell switch is being operated. The different groups of cells pass through exactly the same cycle of work and rest. After having been charged each is connected, for an equal period, first to the 40-volt position where the working load is heaviest, then to the 80-volt and 120-volt positions, where the loads are successively lighter, and finally is thrown once more spare for re-charging. Want of uniformity in the work done by different groups of cells was one of the drawbacks of the system of switching which was previously in use. This has been completely overcome by the introduction of the rotary switches which I have described, and as a result the cells are now maintained much more easily in good condition."

Summary of Discussion on Mr. Purves' Paper.

Dr. Strecker (Berlin) said that in comparison with Berlin the very large number of town telegrams in London was very striking. Was not the reason for this that the telephone system is not yet developed sufficiently to meet the traffic requirements? Could the installation of this complicated system really be justified?

M. Kraatz (Berlin) said it appeared to him that the immediate answering of calls at sub-offices was essential for good service. In Germany the operators at such offices had to attend to other duties besides the telegraph, and he could scarcely see how satisfactory attention could be given.

M. Hollós (Buda-Pest) said Mr. Purves, in his admirable paper, had given diagrams applicable to present-day needs and future development. His solutions were really artistic, and he thanked him in the name of the Conference. This sentiment was greeted with applause.

Mr. Purves, in reply to Dr. Strecker, said there was some unavoidable complexity at the head office, but the apparatus worked well, and was easily maintained, whilst at the sub-offices the arrangements were simple, and very little attention was required. There was scope for cheap telegrams, as well as telephones; the former were more convenient in cases where an immediate reply was not required. Owing to the great size of London with its seven million inhabitants a very cheap telephone service was not possible, and there would probably always be many users of the telegraph

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service, which was both cheap and good. In the city proper, however, the telephone had largely supplanted the telegraph for local purposes, and in future it might be necessary to increase the radius of inter-communication in order to obtain the maximum benefit from it. The inter-communication switch saved the re-transmission of a very large number of telegrams a day, and its financial results justified its existence.

In reply to M. Kraatz, Mr. Purves said that at the smallest offices in London telegrams were only forwarded and not received. The operators at these offices frequently performed other duties, but as they never received telegraphic calls no disadvantage resulted. Generally speaking, at the larger offices where telegrams were received as well as forwarded, the traffic was sufficient to justify at least one assistant for telegraph duties, so that the difficulties mentioned by M. Kraatz did not exist in practice, considerable delay in answering calls being comparatively rare.

THE IMPEDANCE OF NON-UNIFORM TELEPHONE CIRCUITS.

By Prof. G. DI PIRRO, Rome.

This is a mathematical paper. It deals with cases of complex circuits made up of sections having different impedances in series, and with other impedances branched across the telephone loop; also the effect of transformers, etc., in such circuits.

Prof. di Pirro gives a *resumé* of the method of calculation applicable to such cases. In dealing with the question of impedance in telephone lines he has undoubtedly attacked one of the most complex problems in telephone transmission, and such studies form a valuable contribution to the existing literature on the subject. Unfortunately, however, we have available only a *resumé* of the complete mathematical argument which the professor promised, and we feel bound to express some disappointment that a more complete study is not forthcoming.

DESCRIPTION AND USE OF THE METHOD OF MEASURING TELEPHONE LINE CONSTANTS BY THE BARRETTER.

By M. BÉLA GÁTI, Buda-Pest.

M. Gáti first briefly reviews the history of the measurement of telephone currents and then compares the different methods that have been adopted for this purpose. His conclusion is that the

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heating property of the current is the most useful for measuring purposes, and that the Barretter represents the most convenient apparatus for its application. A detailed description of the Barretter and auxiliary apparatus used by the author is given with particulars of the method of calibration and manipulation of the instrument. The author next gives results of tests of the line constants. They are briefly as follows: The insulation of paper cables at a telephonic frequency is less than 1 megohm per kilomètre. The capacity of a paper cable is in general less than that obtained at a steady current value, but the investigations do not yet permit of a general conclusion. For induction coils the effective resistance goes up 200 per cent. to 300 per cent. as compared with steady current measurements. In measuring attenuation on a very short cable, 5 km. in length, the received current was found to be greater than that sent out, and this was found to be so for an open line 40 km. in length. Other experiments are in progress.

Summary of Discussion on M. Béla Gáti's Paper.

Prof. di Pirro (Rome) observed that the low insulation (less than a megohm) found by M. Gáti in telephone cables had serious consequences for long-distance telephony. The smallest value of the attenuation constant was given by the formula $\beta = \sqrt{RK}$, where R is the ohmic resistance and K the conductance per unit of length.

Mr. Hill (London) asked M. Gáti what frequency he had used in obtaining his electrical constants.

M. Gáti replied that 1500 periods per second was employed.

Note on M. Gáti's Paper.

The measurement of telephone line constants is a comparatively new development, and the Hungarian administration are to be congratulated upon being in the van of progress in this respect. One of the most striking points brought out by the tests made by M. Gáti is the apparently low insulation of telephone lines at telephonic frequencies; the frequency taken (1500 per second) was, however, probably much higher than the mean frequency of speech. Low insulation is more serious in the case of loaded than unloaded lines, and yet in practice it has been found by the Post Office that speaking efficiency varies very little within wide ranges of insulation resistance.

Difficulty is, however, generally caused by low insulation—

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which is usually also unequal—and this gives rise to inductive disturbance.

We hope to hear more of M. Gáti's interesting tests in future.

PRACTICAL APPLICATIONS OF THE LAWS OF TELEPHONE TRANSMISSION.

By J. G. Hill, London.

This paper is divided into two parts, the first of which explains the method of standard cable measurement and gives a diagram of connections of the Post Office artificial standard. The writer specially urges the desirability of adopting a uniform standard of transmission for international trunk communication, and points out how standard cable methods would permit of the practicability of any desired service between two given towns in different countries being determined without preliminary experiments.

Detailed examples are given showing how to obtain the cheapest circuit which will be equal to any required standard of transmission.

The second portion of the paper deals with the insertion of Pupin or loading coils in underground circuits.

The greatest improvement obtained by loading Post Office circuits is to increase 3·7 times the length of a cable circuit which can be spoken over. The effects observed in a loaded circuit are complex and best explained by a graph 5. The simplest case is one in which a 20 lb. air-space cable is loaded and compared for efficiency of speech transmission with an exactly similar unloaded cable.

The values along the axis of x represent lengths of unloaded cable, and those along the axis of y indicate loaded lengths of the same cable, the coils being placed in the cable 1 mile apart.

The experimental results, denoted by the crosses, indicate lengths of the loaded and unloaded lines which were found to be equally efficient for speech transmission, and it will be seen that the crosses roughly follow a straight line. If, now, another straight line be drawn parallel to this line through zero it will be found that perpendiculars dropped on to y and x from any point on the line through zero have an invariable ratio, and this is the ratio of the lengths of the loaded and unloaded cables which give equality of speech transmission in the absence of what is known as "terminal loss." Loading, however, always gives rise to simultaneous improvement and loss. The loss is in this case indicated by the length oa along the axis of x, and this is the "terminal loss"; it arises from the difference in impedance between the apparatus and the line, brought about by the addition of inductance to

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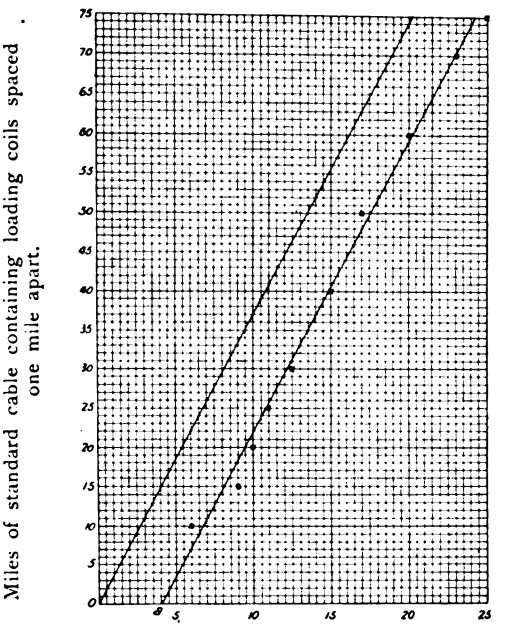
the circuit. The heavier the loading, *i.e.* the more millihenrys per mile inserted in the cable, the greater the loss. It is a constant quantity for all lengths of circuit loaded with the same type of coil, and on very short lengths it may in certain circumstances be so great as to mask the improvement $\frac{y}{x}$. If the inductance of the coils is uniform all along the circuit the loss is greater than if the inductance is gradually tapered at the ends. It is greater



Miles of standard cable without loading coils.
Resistance of cable 85$^{\omega}$ per mile loop.
Capacity, wire to wire, per mile 0·07 mf.
Inductance of two windings of loading coil in series 250 millihenrys.

5.—Chart showing Improvement in Telephonic Speech effected by the Introduction of Loading Coils.

with the speaking apparatus joined direct to the ends of the loaded cable than if a length of unloaded line is interposed between the apparatus and the loaded line.

In fact, even if the inductance is uniform throughout the cable experiment shows that if several miles of unloaded cable, or, say, 50 miles of aërial line, are placed at both ends of the circuit between the apparatus and loaded line, the terminal loss practically disappears.

The attenuation constant of a loaded cable is given by the following formula:

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$$\beta = \frac{R + \frac{R_1}{D} + A\frac{L_1}{D}}{2}\sqrt{\frac{C}{\frac{L_1}{D}}}$$

Where R = Resistance of the line loop per mile.
R_1 = The "effective" resistance of the loading coil.
D = The distance apart of the coils in miles.
C = Capacity of circuit per mile, wire to wire, in farads.
L_1 = Inductance of loading coil in henrys.
A = An empirical constant to be found by experiment.

All the electrical quantities must be effective, *i. e.* in this case they must be the apparent values observed at some frequency agreed upon as representing the mean frequency of speech.

The nearer together the coils are placed in the line the clearer is the articulation of speech, but practically they may be separated at various distances up to three miles apart or more, depending upon the amount of inductance in the coils and the electro-static capacity of the circuit. The maximum distance apart permissible may be calculated as follows :

$$25 = C_1 L_2 D_1$$

Where C_1 is the capacity in microfarads per mile loop.
L_2 the inductance of the coil in millihenrys.
D_1 the maximum permissible distance apart of the coils in miles.

This assumes that a frequency of 2000 per second represents the highest harmonic necessary for speech of sufficiently clear articulation for commercial purposes. It is an arbitrary determination and to some extent a matter of opinion.

A loaded cable of a given transmission value is generally much cheaper than an unloaded one of the same efficiency.

A number of graphs showing experimental results of tests of cable loaded with coils having iron cores and without cores are given.

Summary of Discussion on Mr. Hill's Paper.

Major O'Meara hoped that all the technical adminstrations of Europe would adopt a uniform method of comparing the transmission value of telephone lines. He thought the method adopted in England was sufficiently exact for practical purposes, and trusted that the permanent Committee would undertake the preparation of specifications for a standard cable and standard apparatus in connection with it for general use throughout Europe.

M. Krarup (Copenhagen) said that existing standard cables in different countries had at present different electrical constants. If immediate steps were not taken to secure a cable with fixed constants for general use confusion would result. He thought it would be too

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long to wait till the next Conference and that a small Committee should be elected to consider the matter. He thanked the English delegates for using the mètric system and hoped they would continue its use.

M. Collette (Amsterdam) objected to open a telephone service between two towns in different countries when communication could only be conducted in favourable conditions of line and apparatus as Mr. Hill appeared to favour. The service should at least be good in average conditions.

Prof. di Pirro (Rome) thought the results obtained were valuable, but did not quite see how the comparative values of wires as compared with standard cable had been obtained. He drew attention to the necessity for considering the impedance of circuits in the manner explained by Kennelly, and gave a mathematical example to show that when the impedance of two circuits is materially different, their relative value for speech transmission is not constant at all lengths.

M. Béla Gáti (Buda-Pest) asked whether any telephone speaking experiments had been made on multiple twin cable. It looked as if by bunching, say, with eight conductors, speech could be carried on over several hundred kilomètres.

M. Hollós (Buda-Pest) said the exact value of electrical constants was difficult to obtain by mere calculation, and for that reason it was more useful to rely on practical data such as Mr. Hill gave.

Mr. Hill said he agreed with M. Krarup as to the advantages which would result from the adoption of uniform electrical constants everywhere. He thought Major O'Meara's proposal to refer the matter to the permanent committee was the best way to deal with it.

In reply to M. Collette he recognised that no telephone service should be opened which only worked with difficulty, but he had laid down in his paper definite conditions which ought to be fulfilled before opening any service, and he thought them reasonable. He was of opinion that the committee dealing with the matter should determine by experiment the standard of speech to be adopted.

In reply to Prof. di Pirro, Mr. Hill said that the comparative values of different wires for telephone transmission is the comparative value of their attenuation constants. In ordinary unloaded lines the error introduced by difference of impedance is so small as to be negligible. In loaded lines, however, it was very great, but the standard cable method dealt with in his paper permitted of the losses due to it being readily determined, and this was evidenced by the curves he had given.

In reply to M. Béla Gáti he said that tests had been made on multiple twin cable, but the capacity of wires joined in parallel a pair at a time was 25 per cent. greater than that of one of the com-

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ponent pairs, and as a consequence it would be cheaper to use solid conductors instead of bunched pairs. The multiple twin or quad pair construction was, however, necessary in order to permit of superimposing in cables.

SYSTEMS OF PARTY LINES SERVING SEVERAL TELEPHONE STATIONS.

By F. GUTZMANN, Berlin.

The most common form of party line non-selective arrangement used in Germany is that for so-called "farmers' lines" in rural districts, where there are as many as twenty subscribers bridged on the same line. Ringing is by magneto, the signal bells being of high impedance, and having laminated iron cores instead of solid ones; this is said to give excellent results.

This type of service is only offered where the number of conversations is small and a cheap service is required.

The author next reviews some of the forms of party lines in use in America.

Exhaustive experiments have been made in Germany with the Dean Party Line System, in which the subscribers' bells only respond to impulses having a given frequency which is different for every subscriber. As a consequence of these experiments the Dean system has been modified for German use. For example, the voltage of 180 volts, which is often used in America, has been successfully reduced in Germany to 80 volts by a special design of coils and condensers in connection with the bells at subscriber's office. The frequencies in use are 1000, 2000, 3000 and 4000 per minute. Pole changers, fed by a central battery, are in use for ringing purposes at the Exchange.

Messrs. Hartmann and Braun have furnished a good frequency measurer, and this is absolutely necessary for testing the rate of vibration of the bells and the frequency of the ringers.

Small private exchanges worked by caretakers, etc., are being superseded where possible by what is called a system of "series connection with line choice." The essential features of this are as follows: The junction circuit from the exchange passes through break jacks in series in all the subscribers' offices and terminates in a bell in an attendant's office. In addition all the subscribers have separate lines to each other's stations. Inter-communication takes place on these lines. For exchange connections the subscribers come in on the junction circuit direct and an engaged signal is arranged for. If, however, the exchange requires a subscriber he

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must first call the attendant, who advises the subscriber to come in on the exchange line. The advantage of this system lies in the considerable saving of labour at the exchange and the disadvantage in increased cost of apparatus at subscriber's offices and lines. The subscribers must be relatively near to each other. The feeding of current to private branch exchanges is next considered. With fifty subscribers it is thought that a separate battery charged from the central exchange is best. For small offices dry cells are used. In some cases the number of cells for common battery working may be so excessive that local battery working would be preferable. Not much experience of feeding C.B. private exchanges direct from central battery exchanges has yet been obtained in Germany. A diagram shewing Siemens & Halske's method of feeding from a central exchange to a private branch exchange is given. On this arrangement the exchange connection is fed over the A line and the current for the private exchange over the B line.

An Automatic Strowger Exchange is on trial at Hildesheim. It has a capacity of 1100 subscribers with a present equipment of 900 connections. Connections between the various sub-offices are made by manual operators.

M. Gutzmann reviews at some length the up-to-date technical and financial aspects of party line working. It is quite evident that the German Administration keeps a watchful eye on all modern developments of this branch of telephony.

CUTTING OUT OF CIRCUIT (BLOCKAGE) OF INTERMEDIATE OFFICES ON LONG TRUNK LINES DURING CONVERSATION.

By JOSEPH HOLLÓS, Buda-Pest.

M. Hollós points out that there is a large amount of attenuation to speech currents in those portions of trunk circuits which are in towns and in trunk exchanges, on account of the small gauge wires used, apparatus bridged across the lines at the exchange, and owing to operators breaking in during conversation. He considers the effect on conversation to be so serious as to call for some device for specially cutting out all intermediate offices not actually engaged in the conversation, and an arrangement for that purpose has been developed for use on Hungarian long-distance circuits.

The arrangement is shown by **2**.

The relay of the horseshoe form which we will call relay A has two independent windings, one in the A line and the other in the B line.

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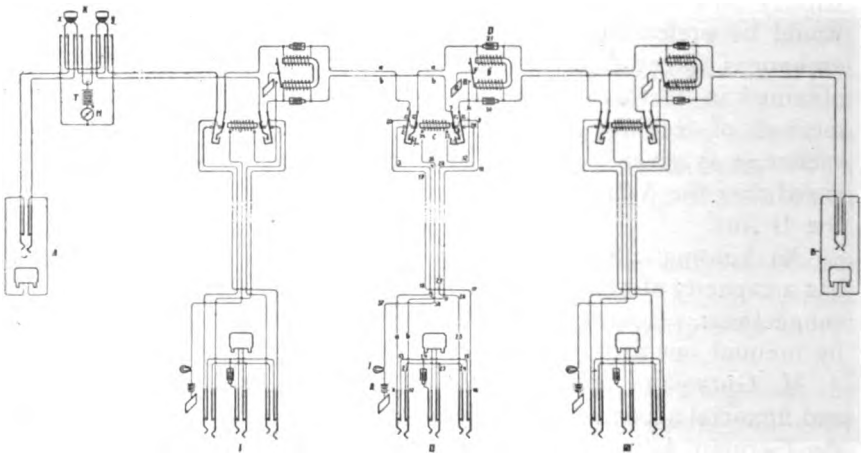
A condenser is, however, joined in parallel with each of these windings and it forms a shunt of low attenuation for voice currents.

The armature of relay A is, when attracted, joined in series with the winding of relay B (immediately beneath relay A), of which it completes the circuit. The armatures of relay B in turn cut out of circuit the four wires constituting the leads of the trunk circuit in and out of the intermediate telephone exchange. At the same time a lamp is lit at the intermediate office in order to give an engaged signal. The relay A can, if necessary, be placed on a pole outside



2.—CONNECTIONS OF A CIRCUIT ARRANGED FOR "BLOCKAGE."

the town in which an intermediate office is situated and it can be actuated by a current sent from a distant office. In this way M. Hollós finds attenuation reduced and speaking on long-distance circuits with intermediate offices proportionately improved.

NOTE ON M. HOLLÓS' PAPER.

One is glad to see how thoroughly the importance of reducing attenuation in long trunk circuits to a minimum is appreciated in Hungary. Probably, however, the conditions as to the number of offices in circuit, the gauge of internal wiring and the length of line led in from the main routes are different from those existing in this country, where the attenuation per office is usually not very great. In cases where long lengths of line are led into an office from a main route the small attenuation introduced by the cutting-out device itself would probably be much less than that due to the line plus office leads, etc. One of the greatest advantages of the device appears to be the prevention of apparatus shunts placed upon the line by operators listening in during conversation.

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MULTIPLEX AND MACHINE TELEGRAPH SYSTEMS, AND DISCUSSION OF CIRCUMSTANCES IN WHICH THEY SHOULD BE USED.

By A. KRAATZ, Berlin.

Monsieur Kraatz states the general principles underlying multiplex telegraphy and machine telegraphy, and gives short descriptions of the Wheatstone system (with simplex and duplex repeaters), the Baudot, Murray, Rowland, Buckingham and Creed systems. Mechanical details are not touched upon, his discussion being confined to the working conditions and the electrical conditions of each system relative to the line used. He favours typewriter keyboards as conducive to the largest output per operator.

He is not sanguine as to the successful issue of the efforts now being made to work Baudot duplex.

The determining factor of speed on long lines is the time taken to transmit a current unit which will be able to actuate the distant receiving apparatus with certainty.

If the required duration of the current unit is equal to t seconds then $S = \frac{1}{t}$ current units per second can be transmitted. If, further, m current units are necessary for a letter and an average word contains n letters the speed of transmission will amount to $\frac{60\ S}{m\ n}$ words per minute. The Wheatstone system, using the Morse alphabet, requires on the average 8 current units per letter, while the Baudot and Murray systems require only 5 current units per letter. In German communications the number of letters per word may be taken as 7; in other languages the number may be 6 or 5. The number S is determined by the material, the capacity and the inductance of the line. Generally accepted values for S are:

$$\text{For iron wires,} \quad S = \frac{8{,}000{,}000}{CR}$$

$$\text{For copper wires,} \quad S = \frac{9{,}600{,}000}{CR}$$

$$\text{For cable wires,} \quad S = \frac{14{,}400{,}000}{CR}$$

As a general case we may write:

$S = \frac{A}{CR}$, where A is a factor depending on the material of the line, C is the *total* capacity, and R the *total* resistance.

The general expression for the speed of transmission is therefore:

$$G = \frac{60}{mn} \times \frac{A}{CR} \text{ words per minute, simplex.}$$

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This assumes that the working capacity of the apparatus used is at least equal to the value G. In duplex working the value of G is not doubled, but after making allowance for various deteriorating factors it may be raised to 1·6 times its value for simplex conditions

Therefore, $G\,dx = 1{\cdot}6\,\frac{60}{mn} \times \frac{A}{CR}$ words per minute.

This method of expression is further developed and applied to various systems.

Advantages and disadvantages of the automatic and multiplex principles respectively are discussed, and the general conclusion arrived at is that automatic systems are, on account of their greater output, best for very long lines, and multiplex systems for shorter busy lines.

DESCRIPTION OF THE METHOD OF SUPERIMPOSING ON TELEPHONE TRUNK CIRCUITS ADOPTED IN FRANCE.

By M. BAZILLE, Paris.

The theoretical arrangement of the superimposed system is shown by **1**. It is found that if the Nos. 1 and 2 circuits are extended to other circuits inductive disturbance results and in practice transformers are inserted, as shown in **2**, in order to overcome the difficulty. The transformers at A, B, C, D **2** are considered to be necessary to maintain a proper balance when the transformer circuits 1 and 2 are extended, but those at E and F are merely inserted to avoid noise due to extension of the superimposed circuit to badly insulated lines. The transformers in use are designed by M. Cailho, a French engineer, and their efficiency is such that they do not attenuate speech to a greater extent than 500$^{\omega}$ resistance inserted in the line. The method of crossing wires on poles utilised in France for telephone circuits is similar to that employed in England, but instead of a quarter of a revolution at every pole a length of 500 mètres is the unit for a quarter revolution.

NOTE ON M. BAZILLE'S PAPER.

If the theoretical arrangement indicated in **1** could be adhered to, the transmission loss on circuits Nos. 1 and 2, due to the insertion of the coils used for superimposition, would probably be negligible, and we should have a highly-efficient superimposed system. If, however, transformers are found to be indispensable, as appears to be the case (*vide* **2**), the problem is quite altered. If the transformers are used

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for all extensions, long or short, as appears to be the case, it is not clear why the coils G, H, J, K could not be dispensed with as is actually done in the system adopted in this country. The transformers at E and F must undoubtedly have the effect of reducing

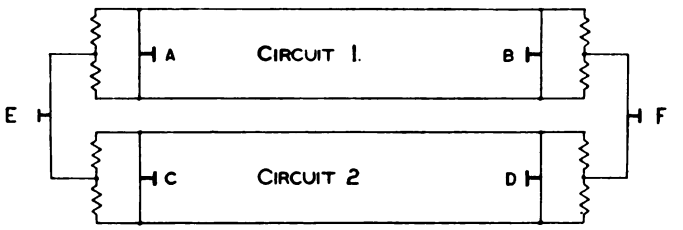

FIG. 1

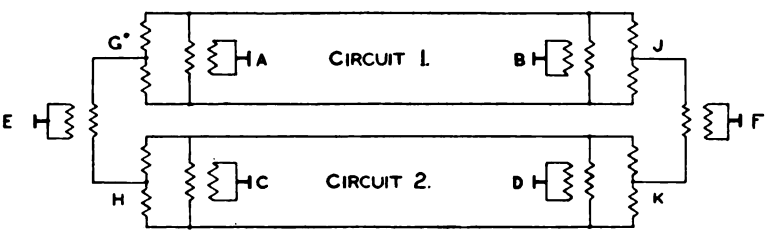

FIG. 2.

disturbance, as is actually found to be the case in France, when the plus circuit is extended to unequally insulated lines, but on the other hand these transformers cause attenuation, and it is interesting to note that they are not considered necessary in plus circuits in this country.

THE BAUDOT TELEGRAPH SYSTEM.

By M. BAZILLE, Paris.

This is mainly a description of the diverse conditions of traffic, etc., that can be met by the Baudot System in some of its special adaptations. These are divided into five categories:

(1) Between two stations served by one wire; service as double, triple, quadruple, or sextuple, the number of channels in each direction being grouped according to requirements.

(2) Three stations, A, B, C, grouped on one wire.

Double echelon, transmissions A to B; A to C.

„ „ complete, transmissions A to B; A to C, B to C.

Triple echelon, transmissions A to B (2); A to C.

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Triple echelon, complete, transmissions A to B (2); A to C, B to C.
„ „ „ special, transmissions A to B (2); B to C (2); A to C.
Quadruple, double echelon, transmissions A to B (2); A to C (2).
„ triple „ „ A to B (2); A to C (2); B to C.

(3) Repeator installations on two-station lines from 1150 to 1200 km. for double Baudot; 950 to 1000 km. for triple, 750 to 800 km. for quadruple, and 550 to 600 km. for sextuple Baudot.

The *rectified* re-transmission effected by the new design of Baudot repeater is described.

(4) Installations serving three stations with re-transmission at the intermediate station. In this category are described amplifications of the conditions in category (2), necessitated by the presence of the repeater at the intermediate station.

The greatest development mentioned is quadruple quadruple on a forked circuit with re-transmissions at the intermediate station B, and comprising eight transmissions—A to C (2), A to D (2), B to C (2), B to D (2).

(5) Installations for underground lines. In general two wires are used for the same apparatus set, one for transmission in each direction. This permits of repetition at intervals of about 150 km. by the simple insertion of a relay in each line.

Communications serving two stations:

Double.—Four simultaneous transmissions.

Double and triple conjoint.—Four or six simultaneous transmissions.

Communications serving three stations:

Double echelon complete, six simultaneous transmissions.

Double and triple echelon complete, six or eight simultaneous transmissions.

Although two wires were until recently considered absolutely necessary for subterranean working, they are now found to be necessary only on long lines. This was demonstrated by experiments which practice has since confirmed.

M. Bazille also discusses operating conditions, and the output of the Baudot apparatus as compared with that of the Hughes.

COMPARATIVE RESULTS OF NEW TELEGRAPH SYSTEMS.

By J. Hollós, Buda-Pest.

M. Hollós refers to the large number of new telegraph systems recently invented, the Rowland, Pollak Virag, Murray, Siemens-

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Halske, etc., and asks the reason why, in spite of this enormous output, these ingenious and excellent devices are not more widely used in practical telegraphy. It is evident that the ideal system of telegraphy must be one which will adapt itself without excessive delay on the one hand, or waste of personnel on the other, to a greatly fluctuating load.

The output of various systems per hour may be taken as follows:

(1)	Morse Simplex .	1,500	words, or in	proportion of	1
(2)	,, Duplex .	2,700	,, ,,	,,	1·8
(3)	Hughes Simplex .	3,600	,, ,,	,,	2·4
(4)	,, Duplex .	5,760	,, ,,	,,	3·84
(5)	Baudot Quadruple .	5,760	,, ,,	,,	3·84
(6)	Rowland Octoplex .	20,000	,, ,,	,,	13·33
(7)	Murray Duplex .	22,000	,, ,,	,,	14·66
(8)	Siemens-Halske .	24,000	,, ,,	,,	16·00
(9)	Pollak-Virag . .	50,000	,, ,,	,,	33·33

But these are figures only. They show that under perfect conditions so many words can be transmitted, but they do not represent telegraph traffic. M. Hollós proceeds to discuss the practical bearings of the matter and various pros and cons in connection with machine telegraphs, multiplex telegraphs, and direct hand-worked wires. He tabulates the relative cost of various systems as follows: the figures are based on a distance of 600 km. and on a traffic of 60,000 words in 10 hours each day.

Item.	1 Hughes Simplex.		2 Hughes Duplex.		3 Baudot Quadruple.		4 Rowland Octoplex.		5 Murray Duplex.		6 Siemens Halske.		7 Pollak Virag.	
	Cost fcs.	%	Cost fcs.	%	Cost fcs.	%	Cost fcs.	%	Cost fcs.	%	Cost fcs.	%	Cost fcs.	%
(1) Line . . .	57,600	50·8	38,400	47·9	38,400	37·9	21,600	27·6	21,600	24·9	21,600	24·1	43,200	39·3
(2) Apparatus .	7500	6·7	8416	9·7	20,000	28·7	10,700	13·7	11,640	13·4	14,490	16·1	14,040	12·4
(3) Personnel (per annum) . .	48,200	42·5	33,800	42·4	33,800	33·4	46,000	58·7	53,700	61·7	53,700	59·8	53,700	48·3
Totals . .	113,300	100	80,616	100	101,200	100	78,300	100	86,940	100	89,790	100	110,940	100

These figures do not profess to be absolutely correct, but M. Hollós thinks the information they give is very instructive, and goes far to explain why so many of these brilliant and ingenious inventions have failed to find favour, and why so many circuits continue to be worked by the Morse Manual System. As a multiplex telegraph he favours the principle adopted by M. Mercadier, which permits of the use of varying numbers of ordinary manual sets on the same wire according to the fluctuation of requirements. He

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thinks that the future belongs to a system which will combine this great flexibility with the use of keyboard transmitters and type-printing receivers.

Major O'Meara furnished the Conference with the following information associated with the subject of Monsieur Hollós communication:

Comparison of the Murray, Wheatstone, Baudot, Hughes, and Morse Quadruplex Systems.

In order to determine the value of the Murray automatic system as compared with other systems in use by the Post Office, it was necessary to ascertain by an actual trial, under uniform conditions, the output, working expenses, and other particulars of each system under review. For this purpose returns were taken of the working of each system during a period of two consecutive weeks between the hours of 11 a.m. and 4.0 p.m. when the traffic is at a maximum.

Only experienced operators were employed during the experiments so as to eliminate, as far as possible, the personal factor.

The results of the trials have been tabulated and are furnished for the information of the Conference.

For the Hughes and Quadruplex systems figures were selected from existing returns of the best fortnight's working on record.

The Murray system is in use only between London and Dublin, and the Baudot system only between London and Paris. It was, therefore, considered desirable to make the Wheatstone experiments between London and Dublin. The Quadruplex trials had previously been made on a London–Dublin circuit and the Hughes on a London–Glasgow circuit.

The traffic conditions between London and Paris differ considerably from those existing between London and Dublin. Between the English and French capitals the stream of traffic available enables the operators engaged in the test to be kept constantly employed, but between London and Dublin one high-speed circuit will comfortably carry all the work and frequently have idle periods.

As several circuits between London and Paris are fully engaged, any delay which may arise cannot be imputed to a particular circuit; and on the other hand the absence of delay on any particular circuit cannot be solely credited to that circuit, since the expeditious transmission of the traffic is dependent on the satisfactory working of all the circuits.

Between London and Dublin there are four Duplex Morse circuits, but the whole of the work was generally disposed of upon a single test circuit, which was worked for one fortnight by the Murray system and for another fortnight by the Wheatstone system.

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It was ascertained that the "circuit delay" with the Murray system, *i. e.* the average period from the time the message was placed at the circuit for transmission to the time that the same message was printed or written up at the distant station, was very nearly the same as that with the Wheatstone system. In the case of the Baudot the delay was erratic, but for the reasons already explained it would perhaps be unfair to compare it with the Wheatstone or Murray.

With regard to the output of each circuit the steady flow of traffic which was always available for the Baudot test circuit during the trial gave it a considerable advantage over the other two systems, on which the stream was by no means continuous. Therefore a comparison of actual output with the Baudot would scarcely be fair, but an attempt has been made to allow for this factor in the tabulated results by showing also the total amount of work that could have been disposed of if the test circuit had worked continuously.

The speed of the Murray was limited by the speed of the receiving apparutus, and this was about 95 words per minute, as a maximum, duplex. The Wheatstone circuit could have been worked up to about 250 words per minute duplex, but as the traffic was not sufficient to justify this speed a speed of 188 words per minute was used throughout the test. The carrying capacity of the Wheatstone circuit, so far as the line is concerned, could therefore have been increased about 25 per cent. on the figures shown in Column 12, Schedule A. The cost for staff would, however, have been correspondingly increased.

It will be seen that the Murray output per *operator* per hour worked out at 31 per cent. higher than the Wheatstone, and the Morse Quadruplex at 46 per cent. higher than the Wheatstone, but in the last mentioned case the strain on the operators is great.

The Murray circuit could not at times carry the whole of the London–Dublin traffic without incurring excessive delay, and additional wires worked by Morse sounder were then brought into use. Three wires were available for this purpose and for occasions when the Murray set stopped for adjustment or on account of apparatus defects, but it is thought that the cost of working and maintaining these wires cannot properly be debited to the Murray system. On the other hand, in comparing the value of a Murray circuit with that of a Wheatstone circuit between two centres, it would perhaps be fair to take into consideration the fact that stoppages of the former are more frequent and of much longer duration than is the case with the Wheatstone system, and that a larger proportion of expensive spare apparatus is therefore required.

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SCHEDULE A.—*Return showing the Actual Amount of Traffic dealt with during Special Experiments covering a Period of a Fortnight between the Hours of* 11 *a.m. and* 4 *p.m. Mondays to Fridays, and* 11 *a.m. to* 2 *p.m. Saturdays, on the undermentioned Systems:*

Wheatstone Duplex	*between*	*London and Dublin.*
Murray Automatic	,,	*London and Dublin.*
Quadruplex	,,	*London and Dublin.*
Baudot 4-arm	,,	*London and Paris.*
Hughes Duplex	,,	*London and Glasgow.*

System.	Circuit.	Period of return fortnight ending	Actual number of messages dealt with.	Average number of words per message, including preamble.	Equivalent number of messages calculated on a basis of 21 words per message.	Number of messages per operator per hour calculated on a basis of 21 words per message.	Sum of idle periods of line due to				Calculated maximum output of 21 word messages assuming no line interruption and sufficient traffic to occupy the wire.
							Line interruptions (hours).	No traffic (hours).	Total time (hours).	Expressed as a percentage of whole period.	
1	2	3	4	5	6	7	8	9	10	11	12
Wheatstone	TS—Dublin	April 11, 1908	12,239	21	12,239	27·2	·2	21	21·2	37·8 %	*19,695
Murray . .	,,	May 16, 1908	12,994	21	12,994	35·7	1·0	6·1	7·1	12·6 %	14,880
Quadruplex	,,	Oct. 27, 1906	8,946	21	8,946	39·9	·6	No record	·6	1·0 %	9,035
Baudot . .	TSF—Paris	April 11, 1908	17,426	18·4	15,268	45·3	1·0	1·0	2·0	3·5 %	15·833
Hughes . .	TS—Glasgow	Feb. 29, 1908	6,380	21·8	6,623	29·5	*Nil*	*Nil*	*Nil*	—	6,623

* At speed of 188 words per minute. At 250 words per minute possible output would have been 26,190 messages.

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SCHEDULE B.—*Schedule showing the Actual Cost incurred by the Different Systems, at the London End of the Circuit only, in dealing with the Traffic represented in Schedule A.*

System.	Circuit.	Period of return, Mondays to Fridays, 11 a.m. to 4 p.m. Saturdays, 11 a.m. to 2 p.m., fortnight ending.	Total number of messages calculated on a basis of 21 words per message.	No. of operator hours.		Cost of staff.		Establishment, etc., charges; 12 per cent. on Columns 7 and 8.	Cost of slip.	Engineering costs from Schedule D.	Total cost per fortnight at the London end.	Cost per 1000 messages at 21 words each.
				At circuit.	Away from circuit.	TS mean of scale 44*s.* (11*d.* per operator hour).	TSF mean of scale (48*s.* 6*d.* (11·62*d.* per operator hour).					
1	2	3	4	5	6	7	8	9	10	11	12	13
						£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Wheatstone	TS—Dublin	April 11, 1908	12,239	408	—	18 14 0	—	2 4 10	0 15 7	0 10 10	24 8 3	1 19 11
					42	1 18 6		0 4 8				
Murray	,,	May 16, 1908	12,994	364	—	16 13 8	—	2 0 0	1 15 0	8 3 0	28 11 8	2 4 0
Quadruplex	,,	Oct. 27, 1906	8,946	224	—	10 5 4	—	1 4 7	*Nil*	0 4 1	11 14 0	1 6 1
Baudot	TSF—Paris	April 11, 1908	15,268	336	—	—	16 5 4	1 19 0	0 3 5	5 2 10	23 10 7	1 10 9
Hughes	TS—Glasgow	Feb. 29, 1908	6,623	224	—	10 5 4	—	1 4 7	0 1 9	1 7 8	12 19 4	1 19 1

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SCHEDULE C.—*Statement of Engineering Costs.*

System.	Life in years (n.).	Capital cost. Cost of apparatus, leads, etc.	Capital cost. Royalties (outright payment).	Interest on Capital (2) and (3) at 3 per cent. per annum.	Cost of maintenance.	Sinking Fund at 3 per cent. per annum for n. years. (See columns 1, 2, and 3.	Establishment charges 15 per cent. on columns 4, 5, and 6.	Contingencies 2½ per cent. on columns 4, 5, 6, and 7.	Total annual expenditure.	Cost per fortnight.	Cost per day.
	1	2	3	4	5	6	7	8	9	10	11
		£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Murray .	8	1020 0 0	600 0 0	48 12 0	144 0 0	167 0 8	53 18 11	10 6 9½	423 18 4½	16 6 1	1 7 2
Baudot .	12	768 0 0	—	23 11 7	148 0 0	55 7 7	34 0 10	6 10 6	267 10 6	10 5 9	0 17 2
Hughes .	13	330 0 0	—.	9 18 9	30 0 0	21 2 8	9 3 1	1 15 1	71 18 10	2 15 4	0 4 7
Wheatstone	13	184 0 0	—	5 10 5	6 14 0	11 15 8	3 12 0	0 13 9	28 5 10	1 1 9	0 1 10
Quadruplex	17	72 0 0	—	2 3 3	3 12 0	3 6 2	1 7 3	0 5 2	10 13 10	0 8 3	0 0 8
Duplex .	15	61 0 0	—	1 13 4	0 16 11	3 5 7	0 17 5	0 3 4	6 16 7	0 5 3	0 0 5
		The Royalty included on the basis of the ten years which the patent still has to run.									

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IMPROVEMENTS IN APPARATUS FOR CLOSED CIRCUIT TELEGRAPH WORKING.

By S. MONTINARI, Rome.

Monsieur Montinari's communication referred principally to the difficulties experienced in closed circuit working through the failure of the operators to restore the continuity of the circuit by replacing the key switch at the end of a communication. This difficulty we can well believe to be a serious one. He described various devices for imparting an automatic character to the key switch, notably one which he had himself devised.

Under the key base he provides a permanent magnet with soft iron pole-pieces projecting through the base. On the key lever is hinged a palette provided at its lower end with an armature of soft iron, which is normally held against the pole-pieces of the magnet and thus maintains the continuity of the circuit through contacts of platinum. The upper end of the hinged palette carries a curved ebonite piece, the normal position of which is just in front of the signalling knob of the key. When the operator grasps the knob the pressure of his fingers naturally forces forward the upper end of the palette and thus breaks the contact between the armature and the magnet poles. This opens the circuit preparatory to the sending of signals from the key. When the contact has once been broken there is little or no pressure of the palette upon the fingers of the operator, but whenever the hand is removed from the key the palette swings into a vertical position, the armature comes again within the influence of the magnet and is attracted. The contact restoring the continuity of the line is thus automatically made and firmly maintained while the key is at rest.

DESCRIPTION OF COMMON BATTERY SYSTEM EMPLOYED IN SWEDEN.

By A. HULTMANN, Stockholm.

Up to the present a Common Battery exchange has not been installed in Stockholm, but a very large exchange is now being built. On account of the large size of the plant the jacks and plugs are to be made very small, and it is considered important to reduce the number of wires in the cord circuit from three to two. It has been calculated in Copenhagen that the difference in the cost of maintenance of 2- and 3-line cords for 15,000 subscribers amounts to nearly £1000 per annum.

In many Swedish towns Common Battery switchboards of the

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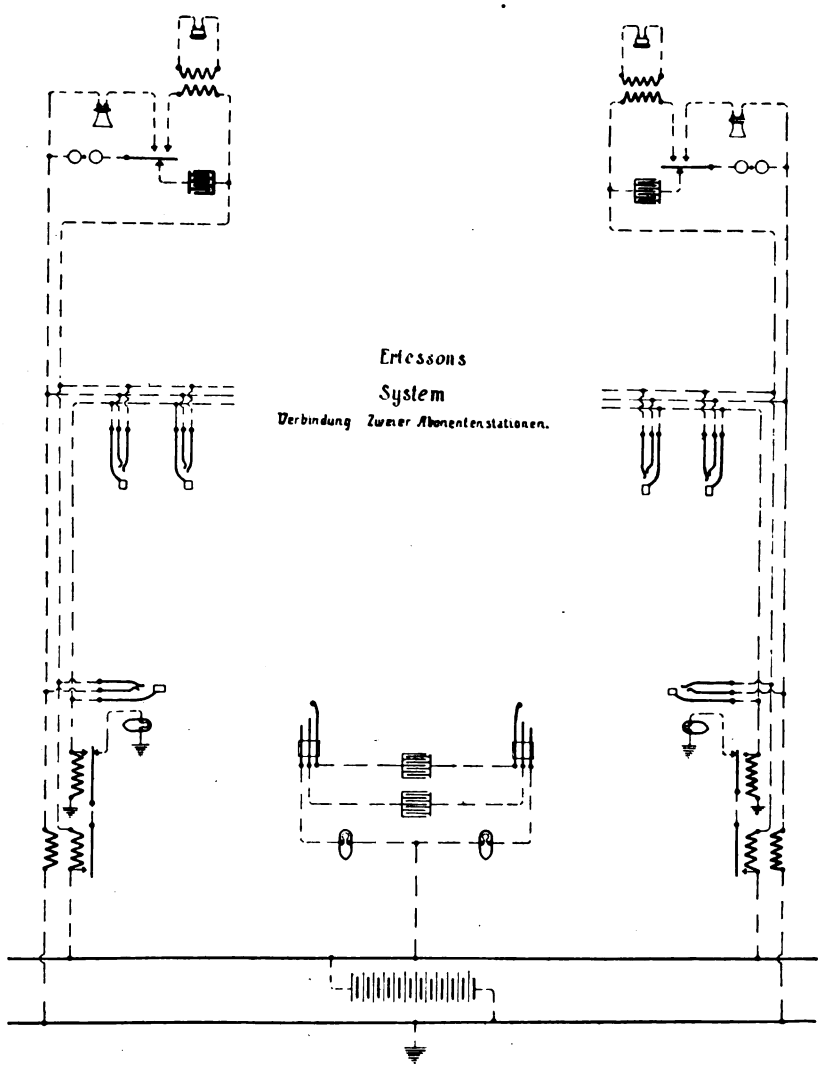
Ericsson type are installed, and the author gives a detailed account of the working of this system.

The main points are that the cord circuit is a 3-wire circuit, the transmission portion of which is arranged on the "Stone"



I.—ERICSSON'S SYSTEM OF CONNECTING TWO SUBSCRIBERS' STATIONS.

system with condensers on the two speaking wires and a signalling relay in the third conductor. There are no "clicks" in the subscriber's telephone as a consequence of inserting or withdrawing pegs at the exchange, owing to the fact that the battery connection with the line is never broken.

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A new feature is a cut-off relay for long-distance conversations, whose function it is to cut off not only all multiple and answering jacks, but also the intermediate switchboard employed in the system and all cabling.

Space does not permit of dealing with the matter at greater length, but the theoretical diagram, 1, is fairly self-explanatory and may be of interest.

M. Hultmann went into the details of the Ericsson system very thoroughly, even going so far as to bring to Buda-Pest two fully equipped working models in order to demonstrate its working practically.

The Ericsson C.B. system is used in many places on the continent, but not in England, although its characteristic features are, of course, well known to telephone specialists in this country.

ANNIVERSARY OF INTERNATIONAL TELEGRAPH UNION.

To commemorate, in 1915, the fiftieth anniversary of the inception of the International Telegraph Union, which dates back to 1865, the recent Lisbon Conference of the Union decided to erect a monument, the cost of which will be about £8000. It was proposed and agreed that the site of the memorial should be in the city where the movement was inaugurated—Paris, but the French Government afterwards suggested that it should be erected in Berne, Switzerland, to accompany the monument about to be erected there by the International Postal Union, in connection with the commemoration of the inauguration of that Union. The amendment was passed, and therefore both monuments will be erected at Berne.

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THE INTERNATIONAL CONFERENCE ON ELECTRICAL UNITS AND STANDARDS, HELD IN LONDON, OCTOBER, 1908.

By MAJOR W. A. J. O'MEARA, C.M.G.

THE year 1908 will be memorable for the large number of International Conferences held during the twelve months in question. At the same time that the Technical Officers of the Telegraph and Telephone Administrations of Europe were attending their first International Conference at Budapest, members of the legal professions and others interested in legal questions were also gathered together at an International Law Conference in the same city; in Paris there have been held International Congresses on Roads, and also on Cold; in London official delegates representing many countries have attended an International Conference on Electrical Units and Standards and also an International Electrotechnical Commission; and this list does not pretend to include all the International Conferences of the year.

Readers of this JOURNAL will be interested to learn that past and present members of the Post Office Engineering Department have taken part, as delegates, in three of these Conferences. An article dealing with the visit of the representatives of the Engineering Department to Budapest appears in the current number of this JOURNAL, and it has been thought that a short reference to the proceedings of the recent International Conference on Electrical Units and Standards may also be of interest.

The latter conference owes its inception to a resolution having for its object the realisation of international agreement on the subject of electrical units, which was agreed to by the delegates of many countries during the Great Exhibition at St. Louis in 1904. The British Government responded to that resolution by making preparations for a Conference on Electrical Units, which was to have been held in London last year. It was, however, found desirable to postpone the consideration of the questions involved for another twelve months, and in consequence the invitations for the Conference were not issued by the British Foreign Office to the countries interested in the question of electrical units until early this year. The British Government has every reason to be gratified with the response to its invitation, for it was accepted by twenty foreign governments, and Australia, Canada, the British Crown Colonies, and India also nominated delegates. Forty-three official delegates, among whom were included many of the foremost men of

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science of the day, took part in the proceedings of the Conference, which was opened by Mr. Winston Churchill, President of the Board of Trade, at the Rooms of the Royal Society on October 12th, 1908.

The President of the Board of Trade, in his opening address, gave a very clear indication of the purpose for which the Conference had been called together; in his own words: "It is not within the scope of such a Conference to formulate laws for governments and nations. It is its business to define in clear and accurate expression those scientific quantities in terms of which electric energy is bought and sold, and if possible to embody its conclusions in draft articles which may form the basis of legislation and administration so far as electric units and standards are concerned. You must not rest satisfied merely with providing that the electric standards of the world shall be identical in 1908; your steps must be directed towards securing a permanent and expanding uniformity."

M. Lippmann (France) and Professor Warburg (Germany) made suitable replies to Mr. Winston Churchill's address, who then proposed the Draft Rules of Procedure, which were based on those of the recent International Conference on Wireless Telegraphy held at Berlin. This proposal was accepted unanimously. The right honourable gentleman, having appointed Lord Rayleigh President of the Conference in accordance with the rules just adopted, withdrew.

The President of the Conference, having taken possession of the chair, nominated the vice-presidents and secretaries, and also appointed a technical committee "to draft specifications, to consider any matter that may be referred to the Committee, and to report to the Conference." These formalities having been completed, Mr. A. P. Trotter proceeded to propose the first resolution, in which the Conference was asked to agree that the fundamental electrical units should continue to be determined on the electro-magnetic system of measurement, with reference to the centimetre as unit of length, the gramme as unit of mass, and the second as unit of time. In his introductory remarks Mr. Trotter explained that the delegates were only being called upon to confirm the system upon which electrical measurements have been based for nearly forty years. He pointed out that the C.G.S. System had been so universally accepted in electrical science and in electrical industry that the ohm, the ampère, and the volt occupy a position of more fixed and international character than is enjoyed by any other unit of measurement. He also took care to point out the importance of maintaining a clear distinction between the unit and the standard. It is generally recognised that it is owing to this very point having been overlooked that some countries now find themselves in trouble in connection with their legislation on electrical standards.

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From the earliest days, in all human activities involving measurements, standards have always made their appearance first, and in this respect there has been no exception in the cases of electrical science and electrical industry, as was pointed out by Mr. Trotter. He brought home to the Conference that telegraphy stands in the position of the earliest pioneer in the field of electrical industry, for he reminded the delegates that the Daniell cell, which accidentally approximated to the volt, and the mile of telegraph wire of former days, which was about seventeen times greater in resistance than the ohm, formed the arbitrary and conventional standards of the early days of electrical industry. He proceeded: "But of so great scientific importance is the system of practical units derived from the absolute C.G.S. units that they have been adopted as the basis of all electrical magnitudes, notwithstanding the fact that the precision of our measurements of standards far exceeds the accuracy of our knowledge of the values of the units they are intended to represent. We know the value of the ampère to a few parts in 100,000, and it is probable that before long our knowledge of the ohm will not fall far short of an equal precision with the advance of physical science; we shall continually approach nearer to the true values, and we do so in confidence that the C.G.S. system of units is a foundation worthy of supporting the monuments which we have raised to the great men whom we honour by recalling the names of Ohm, of Ampère, and of Volta."

The first resolution, having been moved, was agreed to unanimously. This resolution contains that which has perhaps now become a fixed article of faith on the part of scientific men as to the system of units most suitable for all their purposes, and was the only one of the resolutions of real consequence before the Conference on which, it can be said with certainty, *unanimity* prevailed.

The succeeding resolutions gave rise to prolonged discussions, and in consequence a very large amount of space in the JOURNAL would be occupied if they were dealt with fully. Those who desire to go more deeply into the matter will be able to do so when the proceedings and minutes of the Conference are published. In this article it is proposed only to touch very briefly on the various matters discussed by the Technical Committee, and the action taken by the Conference on the resolutions brought before it.

The second resolution, which was also moved by Mr. Trotter, ran as follows:

"As a system of units representing the above and sufficiently near to them to be adopted for the purpose of trade and commerce, the Conference recommends the adoption of the International Ohm, the International Ampère, and the International Volt, defined according to the following definitions."

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The use of the words "for the purpose of trade and commerce" in the resolution gave rise to some discussion, and M. Lippmann (France) pointed out that three propositions were included in the resolution. It was agreed that it would be premature to adopt the resolution at this stage, and in consequence its further consideration was postponed. The question was further debated at the third meeting of the Conference, and finally the resolution was amended to read:

"As a system of units representing the above and sufficiently near to them to be adopted as a *basis for legislation*, the Conference recommends the adoption of the International Ohm, the International Ampère, and the International Volt, defined according to the following definitions."

There was still some doubt in the minds of some of the delegates as to the appropriateness of the words employed, and it was suggested that the word "standards" should be substituted for "units." The resolution in the amended terms was, however, put to the vote and carried, twenty-one countries being for and three against the resolution.

The definition of the International Ohm consisted of two parts, and both resolutions dealing with this standard were moved by Professor Warburg (Germany). The first part simply declared the unit resistance to consist of a "specified column of mercury," whereas the second part gave the dimensions of the column and also referred to a specification for setting up the standard.

Lord Rayleigh felt some doubt "as to whether the introduction of the mercury column was not what we call a fifth wheel to the coach." Some of the delegates appeared to share His Lordship's views, although they did not openly declare their convictions at this stage in the proceedings.

The resolution relating to the use of a mercury column was put to the vote and carried unanimously. But the resolution dealing with details was, after some discussion, referred to the Technical Committee, for not only was an objection raised to the addition of two zeros after the "3," in the length 106·3 cm. of the column, but Dr. E. B. Rosa (United States of America) also put forward a proposition to define the length of the mercury column as exactly one metre, which also involved an alteration in the mass of the mercury employed in the standard, so as to produce the exact equivalent of the International Ohm proposed in the resolution. The Technical Committee, having fully discussed the matter, recommended that no change should be made in the length of the mercury column, and finally the resolution on the subject was carried in the form originally proposed.

It must be admitted that the Conference has laid itself open to

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criticism by the acceptance of the final resolution relating to the International Ohm. It has been pointed out that a vast amount of good work has been lavished upon the perfecting of mercury columns in general, and that they can now be so set up that the ideal length of 106·3 cm. and ideal mass of 14·4521 gms. will not differ from one another by more than a few parts in 100,000. It is stated that, on the other hand, too little has been done of late years to arrive at a more accurate determination of the absolute specific resistance of mercury so as to determine whether the representative mercury column should be 106·26, 106·27, or 106·3 cm. Consequently the accuracy of mutual agreement on the length of the column has outrun the accuracy with which the column needed to represent the ohm has been ascertained. The specification prescribing the method of setting up the mercury tubes renders it necessary to take the mean of three fillings of five tubes to determine the value of the mercury unit. To this the objection has been raised that "instead of a concrete standard, we are confronted with a research in which the mean of at least fifteen experiments is to be taken as defining a value, and when the mean has been calculated the value is a fictitious quantity representing an ideal column of an arbitrary length, which, for all we know at present, may be itself in error to the amount of 3 or 4 parts in 10,000!" (Professor S. P. Thompson).

The resolutions relating to the ohm having been disposed of, the Conference turned its attention to the choice of the second primary unit. The delegates of the United States of America, who were supported by M. Lippmann (France), were desirous that the volt should be adopted as the second primary unit. M. Lippmann, in supporting the amendment to the resolution before the Conference that the ampère should be the second primary unit, said: "Now I think it has been generally overlooked that the volt is an independent quantity which can be measured without any kind of resistance, measured by a direct and simple method. I will show you how that is possible. Let us consider a revolving disc, such as that of the British Association, revolving in the magnetic field of the earth and inducing an electro-motive force. When that force is at its maximum we can oppose it by the E.M.F. of a standardised cell. That can easily be done. The value of the electro-motive force is known very easily—it is H.S.ω." But M. Gérard (Belgium) pointed out later that this method presented a difficulty, as it became necessary to ascertain the intensity of the magnetic field of the earth, which is a problem not without its own difficulties.

After a very full discussion the Conference adopted the resolution, making the ampère the second primary unit by nineteen votes for and four against.

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The succeeding resolution dealt with the realisation of the ampère by the voltameter method. It was proposed by Dr. Glazebrook that the International Ampère should be the unvarying current which "deposits silver at the rate of 0·00111800 grammes of silver," *i. e.* as in the case of the mercury column it was proposed to add two final zeros (after the "8" relating to the mass of the silver deposit). This resolution was much discussed, and it was felt by many of the delegates that either the zeros should be omitted, as they were meaningless, or, if a change must be made, then the figures to follow the "8" should coincide with the latest determinations of the electrochemical equivalent of silver, in which case it was suggested that a "2" should follow the "8." It was further suggested that the International ampère should be defined as one tenth of the electromagnetic unit in the C.G.S. system. As regards the latter suggestion, Lord Rayleigh pointed out that it would be inconsistent to go back to the C.G.S. unit for the ampère in view of the fact that the Conference was prepared to accept the mercury ohm. The proposal to adopt the C.G.S. unit for the ampère was put to the vote and lost. The question as to whether the last two figures in the mass of silver deposit representing the International Ampère should be two zeros or not was referred to the Technical Committee.

Immediately after the Conference had decided to refer the questions relating to the International Ampère to the Technical Committee, Dr. Glazebrook moved a resolution which provided for the International Volt being defined according to Ohm's law, and this resolution was unanimously agreed to by the Conference.

The Technical Committee went very fully into the question relating to the International Ampère which had been referred to it, and endeavoured to provide a solution of the difficulty which had arisen. There could be no doubt that a very strong feeling existed on the question, and was openly expressed by some of the delegates at the meeting of the Committee. On a vote being taken as to the figures which should follow the "8" in 0·00111*8*, eight members of the Committee were in favour of "20" being added after the "8" and five members voted for "00"; the Chairman of the Committee (Dr. Glazebrook) abstained from voting.

Unfortunately, when this question relating to the International Ampère next came before a meeting of the delegates, the Report of the Technical Committee on the point referred to it was not laid before the Conference, but the resolution was again moved in its original form, containing the addition of two zeros after the "8" in the mass of the silver deposit. Twenty-one countries cast their votes for the resolution whilst three countries opposed it. It became evident at a later stage of the proceedings that there was a

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misunderstanding on the part of some of the delegates as to the terms of the resolution on which they had been called upon to vote, and an embarrassing situation was created by the subject being again debated at some length. The rules adopted at the commencement of the Conference made it necessary that resolutions which had already been passed should be confirmed by a second vote. The resolution relating to the International Ampère was therefore brought before the Conference for confirmation, with the strange result that on this occasion thirteen countries only voted for the resolution, eight countries opposed it, whilst three countries abstained from voting.

A resolution defining the International Watt as "the energy expended by an unvarying electric current of one International Ampère under an electrical pressure of one International Volt" was moved in order to meet the views of the Canadian delegate, and was carried unanimously.

Propositions were also placed before the Conference relating to the establishment of an "International Electrical Laboratory, with the duties of keeping and maintaining electrical standards." After some discussion the wording of the resolution was altered, and in its final form became the pious expression of opinion that the establishment of such an institution was "the best method of securing uniformity for the future" in electrical standards. The amended resolution found ready acceptance, and when put to the vote was carried unanimously.

A resolution recommending that the various Governments interested should "establish a permanent International Committee for Electrical Standards" was also carried unanimously.

And finally, on the recommendation of the Conference, Lord Rayleigh appointed "A Scientific Committee of fifteen to advise as to the organisation of the permanent Commission, to formulate a plan for, and to direct such work as may be necessary in connection with the maintenance of standards, fixing of values, intercomparison of standards, and to complete the work of the Conference."

A close examination of the discussions of the Conference shows that these have for the most part arisen on the important question as to whether the international units shall be defined as closely as possible in accordance with the true C.G.S. units, or as to whether they shall continue to be arbitrary values as hitherto. Those who have been in favour of the adoption of the latter course have laid much stress on the importance of continuity in the matter of standards for commercial and trade purposes, and have admitted that for purposes of scientific investigations naturally the most exact value will be adopted in the case of the units concerned.

It must not be thought that because the Conference has added two zeros in defining the values of the ohm and the ampère—figures

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which it has been said have no scientific meaning whatever—that, therefore, no progress has been made. It is clearly a step in advance for the delegates of all the countries represented to have agreed no longer to regard all three units as primary, and at the same time to have come to an understanding as to which of the two out of the three units shall be regarded as primary.

It is further admitted that the definitions of the International Ohm, Ampère and Volt have been made more precise, a distinction now being drawn between the ohm—10^9 C.G.S. units of resistance, and the International Ohm—the resistance of a column of mercury; and similarly with the ampère and the International Ampère. It must not be supposed that the Conference wished it to be understood that the figures adopted in the definitions are absolutely exact; as a matter of fact it was stated more than once that it was certainly known, in the case of the figures adopted for the electro-chemical equivalent of silver, that they were not accurate.

The resolutions adopted by the Conference involve no change in the standards of this country. These standards are maintained by the Board of Trade, and legal sanction was given to them by an Order in Council in 1894. The standard ohm consists of a verified wire of alloy, the standard ampère is measured on a verified ampère balance, and the standard volt is similarly measured by a verified device.

During their stay in this country the delegates were entertained at an official banquet given by the British Government at the Hotel Ritz. The President and Fellows of the Royal Society and the President and members of the Institution of Electrical Engineers also entertained the delegates at dinner, and visits were arranged to the National Physical Laboratory, the Royal Observatory, the Board of Trade Laboratory, the Cavendish Laboratory, Cambridge; the G.P.O. Telephone Exchanges in Carter Lane, the Central Telegraph Office, and other places of interest.

The importance of the position of London's Lord Mayor is widely recognised, and it therefore gave the foreign delegates great pleasure to be entertained at the Mansion House, where Sir John Bell, the Lord Mayor, and some of the Sheriffs and Corporation, robed in all their splendour, received the guests, the foreign delegates being much impressed.

Thus opportunities were afforded to the delegates for becoming acquainted with one another, and many of us feel the richer by the friendships which we have had the good fortune to make owing to our participation in the work of the Conference.

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REMINISCENCES OF OVERHEAD AND UNDERGROUND TELEGRAPH WORKS.

By G. W. Hook,

Superintending Engineer, South Midland District.

(*Continued from p.* 185.)

In 1894–5 the Department undertook to provide for the National Telephone Company a large number of 304-wire air-space paper insulated cables in various parts of the city of London, and concurrently the Post Office had also become busy with the same class of work, so that it became necessary to devise the best form of joints, etc., and to train a special staff of jointers and cable hands. Owing to the hygroscopic properties of the paper a considerable amount of moisture was taken up by the latter at the joints during the process of jointing, not only from the atmosphere, but from the perspiration of the hands of the jointer. The National Telephone Company adopted the use of hot powdered lime, plentifully laid on the completed cable core joint and allowed to remain some time to absorb the moisture. I did not follow this example because I had found that the moisture crept up the lead sheathing at each end of the joint where the lime could not reach it, and another reason was that I was afraid that sooner or later the lime would have a damaging effect on the lead. I therefore adopted the course of applying the charcoal brazier to the main cable about a foot away from the joint, each side alternately, in order to drive out any moisture which had penetrated the cable, and then finally to dry out the joint itself and test the latter for moisture by holding over the centre of the joint a piece of cooled silvered glass, which revealed the slightest trace of vapour. This idea suggested itself to me from having read of this method being resorted to for detecting the breathing of apparently dead persons.

Another and peculiar difficulty cropped up in connection with the plumbing of the lead sleeves. The plumbers found that the heat of the metal put on one end of the sleeve expanded the air in the sleeve to such an extent that when they proceeded to put the metal on the other end air bubbles passed through, allowing microscopical veins to form through the solder which, if allowed to remain, might sooner or later let water through to the joint. In order to meet this difficulty as far as possible I had a small slot cut in the top of the sleeve to provide a vent for the expanded air, and then after the two ends of the sleeve were wiped this slot was hammered and rubbed down, and a close-fitting patch of lead sheet carefully wiped over the closed gap. This method has been universally adopted, and although the

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small blow-holes above referred to are still liable to appear if the seam has not been effectually closed before the patch is wiped on, they are driven to the top side of the sleeve, where they can be more readily detected than in the joint connecting the lead sleeves to the sheathing. Since the testing of plumbing work by means of air pressure and soap-suds has been introduced minute faults are frequently detected, and they are mostly found to be in the top patch, thus proving, I think, that the expanded air inside the sleeve is driven to the point of least resistance.

While the above-mentioned work was in progress it was whispered about that the laying of a paper-insulated lead-covered cable between London and Birmingham was under contemplation, and one day in December, 1896, I was called to the Chief Office, where I was informed by the Engineer-in-Chief that authority had been received for the cable to Birmingham, and that I had been chosen to superintend this important pioneer work. The work involved the laying of the line of pipes from Cricklewood (the boundary of the Metropolitan and South Midland Districts) to Birmingham Head Post Office, and the drawing-in, and jointing, of the cable between G.P.O. London and Birmingham H.P.O. The pipe-laying was carried out by contract in ten-mile sections, the contractors supplying the pipes. The pipes had to be gauged and examined on the ground by the Department's men under my control, and very great trouble and inconvenience was frequently caused owing to the numerous rejections through smallness of gauge, rough interior surface, iron scab, and other defects. I frequently had occasion to reject a whole railway truck load of pipes, and return them to the makers. Pipes are now examined, tested, and stamped at the manufacturers by the Department's officers, which is a more satisfactory arrangement in every respect. It very rarely happens that a pipe thus passed has to be rejected, which shows that great care is exercised in the work.

The first sod was turned early in January, 1897, and in March, 1897, the first length of cable was drawn into the pipes at Watford. The late Mr. Hookey (at that time Assistant Engineer-in-Chief), Mr. J. W. Woods (then Superintending Engineer S.M. District and now Assistant Engineer-in-Chief) and myself gave the first few turns of the crab winch.

During the three years the work was in progress we had many vicissitudes, but with the able assistance of the three or four officers Mr. Fleetwood (my then Superintending Engineer) kindly allowed me to take from the Metropolitan District, the principal one being Mr. J. T. Langley, now an engineer attached to the Metropolitan Central District, we managed to get over all our difficulties. We had to train our clerks of works, jointers, and others on the road.

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The work which caused me most anxiety was the plumbing. There are over five thousand plumber's joints on the cable, and when it is remembered that at that time the method of testing by air-pressure had not been introduced, it is a matter for congratulation that the faults caused by defects in plumbing have been practically negligible. The last length of cable was drawn into the pipes in Hill Street, Birmingham, on April 9th, 1900, Mr. J. W. Woods and myself officiating at the crab winch for a few turns.

During the progress of the work we had many visitors—not only officers of our own department from different districts, but from many foreign countries, including Japan and America—each of whom made voluminous notes, and all were exceedingly interested in the operations.

I have given a description of the practical portion of this pioneer work, and I leave it to abler pens than mine to give the electrical results. Many well-known men I can name spent much time on experimenting as the work proceeded. Among them I may mention Mr. A. J. Stubbs, Mr. H. R. Kempe, Mr. F. Tremain (who, when I returned to London, was busy with experiments on the advantages of loading coils), Mr. A. W. Martin, and the late Mr. J. W. Leyshon. These gentlemen were frequent visitors to the work, and I wonder whether Mr. Kempe still remembers the organ incident at Great Brickhill Church one day when we were driving from Leighton Buzzard to Fenny Stratford to conduct some tests. It happened this way. Mr. Kempe, Mr. J. W. Woods, the late Mr. Leyshon and myself were passing through Brickhill, and knowing that these gentlemen were interested in old churches I asked them if they would like to visit the church, an interesting and historical old building just off the main road we were then passing along. They were quite agreeable, so we turned down to the church, alighted, and walked in. Mr. Kempe, as no doubt many of my readers well know, is a lover of music, and has a great partiality for church organs; the late Mr. Leyshon was also a man of much musical ability. After looking over the church and passing through the chancel, we came to the organ, the keyboard of which was found to be open. Mr. Kempe and Mr. Leyshon were fingering the keys and stops in dumb show, remarking as to their various merits. I cannot play the organ myself, but I thought it a pity not to make the pipes speak, so I slipped round to the back and pumped the bellows up. Immediately the sacred edifice was filled with beautiful strains from the organ, the performers being Messrs. Kempe, Leyshon, and Hook, while Mr. Woods comprised the audience. In a few minutes someone entered the church who proved to be the Vicar, and by the sound of his footstep we could tell that he was *cross*, to say the least of it. He gave us a severe rating for interfering

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with what did not concern us, and then shut down the keyboard with a bang, and walked out of the church. We left directly afterwards, and I am unable to recollect whether we dropped the usual coin in the church box on that occasion!

The cable is looped into test pillars, and joined up to cable connection boxes at approximately five-mile points, and these have proved to be of assistance in localising the few minor faults which have occurred, and enabled us to locate and make good the wires before the circuits have reached breaking-down point.

Towards the completion of the work I was engaged under Mr. M. F. Roberts, Assistant Engineer-in-Chief, in experiments at Leamington, to ascertain the best method of duct-formation for the approaching London telephone scheme, and I expect there are not many who are aware that the first length of duct work (sixteen ducts) lies under the roadside waste about a mile south of Leamington.

On the completion of the Birmingham cable I returned to London and took charge of some of the large contracts in connection with the London telephones, and in October, 1901, I was appointed to the post of Superintending Engineer of the South Midland District, so that I became responsible for the maintenance of the pioneer long-distance cable, the laying of which I had been so intimately connected with. I am glad to say the maintenance cost up to the present has been almost a nominal quantity, being mainly the cost of painting marking posts, and test pillars.

Soon after taking up my post in Birmingham the extension of the main cable to Nantwich was authorised; the length being approximately 58 miles, and the number of wires 103. This was built up in sections of six cables, with an air-drying nozzle at every sixth joint, the latter being enclosed in a small buried joint-box. In the case of this cable we had the advantage of being able to prove all the plumbing work by means of air pressure and soap-suds. As each section of six cables was completed and tested it was coupled up with the back section by means of a sleeve with an air nozzle fitted, and the plumbing of the latter tested by the same means as the other plumbing work. Minute defects in plumbing were discovered by this test. I have watched small bubbles grow from the size of a pinhead to the size of a pea, which clearly indicated a slight defect in the plumbing, in which case the metal was rewiped, and again tested. This cable was completed about four years ago, and the only maintenance cost has been the time of the officer taking the monthly test. This satisfactory result is a great credit to the young engineers through whose sections the cable passes, particularly as they had had little previous experience of underground work.

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The cables throughout were laid in uniform lengths of 150 yards, that being considered from experience a safe and workable length, and I would caution engineers not to be over venturesome in drawing in excessively long lengths, especially into old pipes, for fear of stretching the lead sheathing. As a case in point, I would mention one which occurred in my district where a small cable had to be drawn into an old line of pipes. The cables were delivered in long lengths with sufficient margin for joints, but when I reached the ground I found that the engineer had, in order to save a couple of joints, pulled in an excessively long length. When I called his attention to the matter he pointed out that it had been pulled right up to the point where the solid plug had to be fixed for the leads to be taken into the telegraph office. I waited with him to see the jointers cut the end of the cable for the purpose of fixing the solid plug, but to the engineer's surprise no conductors could be found. Eventually they had to cut away about four feet of sheathing to get to the conductors, showing that the lead had elongated somewhere, thus considerably weakening the cable. It is a mistake to pass the margin of safety for the sake of the doubtful saving of the cost of a joint or two.

In conclusion, I would like to mention one point in connection with the London-Birmingham cable which may surprise some of my readers. On December 12th, 1901, occurred the great snow-storm in the midlands which broke down all overground lines, the only circuits working into the Birmingham Office being those brought in by the cable.

I got through to the Engineer-in-Chief in London (the late Mr. Hookey) on the centre pair of wires in the cable, and I kept the Engineer-in-Chief advised telephonically of the extent of the damage from my office to his. The speech was not *commercial*, but we were able to sustain a conversation.

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ON THE PROPAGATION OF PLANE ELECTRO-MAGNETIC WAVES ALONG A PLANE CONDUCTING SURFACE, AND ITS RELATION TO WIRELESS TELEGRAPHY.

By J. ZENNECK.
(Translated by H. HARTNELL, A.M.I E.E.)

(*Continued from p.* 220.)

B. RESULTS WITH REGARD TO WIRELESS TELEGRAPHY.

7. *Applications of the Results to Wireless Telegraphy.*

IT is obvious that the foregoing results can only be applied to wireless telegraphy with many limitations, but at great distances from the transmitter it is probable that the waves sent out glide along the surface of the earth in a manner very similar to that assumed in Section 1.

8. *Conductivities and Dielectric Constants of Various Earths, etc.*

In the literature of this subject I found among others the following values:

	σ in C.G.S.	$k = \epsilon/\epsilon_0$.
Sea water	10^{-10} to 10^{-11}	about 80.
Rain, river water	10^{-13} ,, 5×10^{-15}	about 80.
Slate	10^{-15} ,, 10^{-16}	
Marble	about 2×10^{-18}	about 6.

The dependence of the conductivity and dielectric constant of various earths on the amount of moisture contained in them has been investigated by W. Eickhoff. His results are summarised in the following table:

Material.	Percentage of water.	Conductivity σ in C.G.S. units.
Yellow river sand	0	$< 10^{-16}$
,,	1·52	$2{\cdot}6 \times 10^{-14}$
,,	3·3	5·9 ,,
,,	7·4	9·7 ,,
Garden soil	3·3	0·6 ,,
,,	5·7	2·1 ,,
,,	10·0	6·4 ,,
,,	17·3	16·8 ,,
Clay	4·4	0·69 ,,
,,	9·2	6·7 ,,
,,	16·1	20·0 ,,
,,	45·0	69·0 ,,

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Measurements of the dielectric constants with very high frequencies gave:

	k
Yellow river sand, dry	2·5
„ „ „ with 15 per cent. moisture about	9
Garden soil, dry	1·9
„ „ with 19 per cent. moisture about	8
Clay, dry	3·5

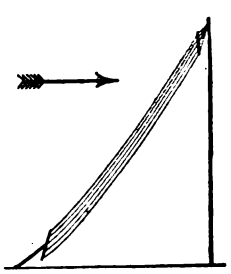
For practical purposes we may assume:

Sea water	$\sigma = 10^{-11}$	$k = 80$
Fresh water	$= 10^{-14}$	$= 80$
Moist earth	$= 10^{-13}$ to 10^{-1}	$= 5 - 15$
Dry earth	$< 10^{15}$	$= 2 - 6$

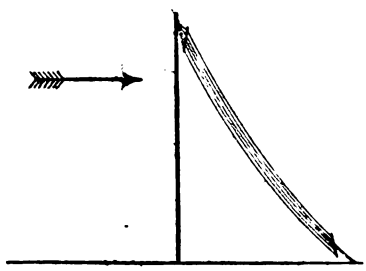
9. *The Electric Fluid at the Surface of the Earth.*

(*a*) The case of propagation over the surface of water is of little interest. The direction in which the electric field strength has its greatest amplitude never deviates much from the vertical; about 6° is the maximum. Practically speaking the field is always an alternating field perpendicular to the surface.

(*b*) In the case of dry ground the case is quite different (*v.* **5** and **6**). Here there may be a strong turning component or the alter-



9



10

nating field may be considerably inclined with respect to the vertical. *In both cases the direction in which the amplitude of the electric field-strength is a maximum, varies considerably from the vertical.* In the case shown in **5**, for example, the angle may be 35°. In this case it is therefore desirable to incline the receiving antenna as shown in **9**, in which the arrow shows the direction of the incoming waves. With the constants of **5** a vertical position of the antenna would give about 18 per cent. less amplitude than the position shown in **9**, and the position shown in **10** about 66 per cent. less.

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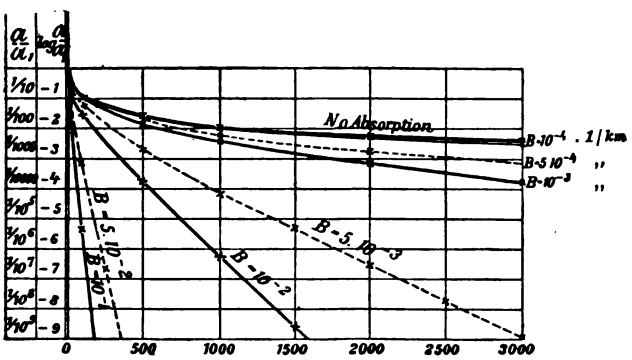
10. *The Absorption of Waves along the Surface of the Earth (cf. Section 4).*

(*a*) If there were no absorption the amplitude would be very nearly inversely proportional to the distance x from the transmitter. This decrease of amplitude ($\sim 1/x$) is therefore always present. It is only when, in comparison with this, the reduction of amplitude due to absorption is appreciable that absorption is of practical importance.

With reference to 11, the curves give the common logarithm of the ratio of the amplitude a at the point x to the amplitude a_1, at a point 1 kilomètre distant from the transmitting antenna. As will be seen up to a value of $B = 10^{-4}$ the absorption is without appreciable effect.



Distance x in kilomètres.

11.—The Upper Curve is the Line of No Absorption.

(*b*) With sea-water, and even with fresh water, the absorption does not play any part in the maximum range. Taking the frequency used in wireless telegraphy a maximum effect is obtained when the value of σ lies between 10^{-13} and 10^{-14}. With dry soil, on the contrary, the absorption may become very important. This is in accordance with experience. This result is due as much to the high value of the constant k as to low conductivity.

(*c*) Considering the curves (11) in the manner indicated in paragraph 4 it is seen that powerful stations with long wave lengths are more advantageous from the point of view of absorption than small stations giving shorter wave-lengths, when the conductor consists of slightly moist ground, or even of fresh water. In the case of sea-water or very dry ground the superiority of powerful stations disappears since absorption becomes either of little importance or is independent of the wave-length.

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11. *Influence of the Conductivity of the Air.*

(*a*) According to the observations hitherto made the conductivity (σ_0) of the air near the earth's surface is approximately $\sigma_0 = 2 \times 10^{-25}$ C.G.S. units. If we make this mean value the basis of the calculation $\beta = \frac{\sigma_0}{\sigma}$ will be very small not only in comparison with unity, but also in comparison with q_0. We consequently obtain from equation (7) the following expression :

$$s = -\sqrt{aq_0 \frac{1 + \iota q}{1 + \iota (q + q_0)}} \left[1 - \frac{\iota \beta}{2 q_0} \frac{1 + \iota q}{1 + \iota (q + q_0)} \right].$$

In Section 4 we saw that so long as we could assume that $\beta = 0$, s might be written $s = -(A - \iota B)$.

If now for a given value of β we write it in the form $s = -(A^1 - \iota B^1)$, the relation between the absorption co-efficient B^1 and the former value B approximates to—

$$B^1 = B + A \frac{\beta}{2 q_0}.$$

A, under the assumed conditions, never varies greatly from $\frac{\pi}{3} \times 10^{-4}$ C.G.S. units ($\nu = 10^6$/sec.). $\frac{\beta}{2 q_0} = \frac{\sigma_0}{2 \nu \varepsilon_0}$ has for the assumed magnitude of σ_0 the value $0{\cdot}36 \times 10^{-9}$. Consequently the increase of the absorption co-efficient on account of the conductivity of the air—

$$\frac{A \beta}{2 q_0} = \frac{\pi}{3} 10^{-4} \times 0{\cdot}36 \times 10^{-9} = 0{\cdot}4 \times 10^{-13} \text{ per cm. approximately.}$$

(*b*) The conductivity of the air at the surface of the earth may rise to about five times the mean value (2×10^{-25} C.G.S.) assumed above, and at a height of 6000 mètres may in favourable circumstances rise to about ten times the value at the earth's surface. If we take as an extreme value 100 times the mean value assumed above, the increase of the absorption co-efficient will be :

$$\frac{A \beta}{2 q_0} = 0{\cdot}4 \times 10^{-11} \text{ per cm.} = 0{\cdot}4 \times 10^{-6} \text{ per km.}$$

therefore $B^1 = B + 0{\cdot}4 \times 10^{-6}$ per km.

(*c*) A glance at the value of $\frac{1}{B}$ in 7 shows immediately that the conductivity σ of the ground $\leqq 10^{-12}$ C.G.S., *i.e.* in the case of fresh water and solid earth the conductivity of the air does not play any part.

In the case of sea-water of high conductivity ($\sigma = 10^{-10}$ C.G.S.) $B = 1.5 \times 10^{-5}$ per km. In the case of sea-water of very low conductivity ($\sigma = 10^{-11}$ C.G.S.) $B = 1.5 \times 10^{-4}$ per km. The

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increase of the absorption coefficient, therefore, amounts in the first case to about 2 per cent., and in the second case to 0·2 per cent. In the first case also the increase in the absorption through the conductivity of the air is therefore without practical significance.

(*d*) There is, as is well known, a remarkable difference between the range of action of a station by day and by night. According to Marconi, the range by night is 2½ times greater than by day. As a possible explanation of this fact, Marconi points out that the absorption of the waves is increased in consequence of the air becoming ionised by sunlight. From this it would follow that layers of air which are less than 6000 mètres from the surface of the earth are not responsible for the phenomenon. Until it can be proved that layers of air at a greater distance from the earth than this are, by the action of sunlight, rendered conducting to a much greater extent than has yet been observed, this explanation cannot be considered satisfactory. A second explanation, to which also Marconi has called attention, is that in consequence of the action of sunlight the discharges of the antenna and the consequent losses of energy are increased. The preference must be given to the former explanation.

12. *Influence of Fog.*

In connection with the favourable effects of fog on the range of action of a station the following causes may be considered:

(*a*) The dielectric constant of air containing a considerable amount of moisture must be greater than that of air free from fog, and, as a consequence, the capacity of the antenna must be increased. Assuming that this increase in the capacity always takes place, its effect would not always be favourable, especially in the case of stations worked by means of loose coupling and sensitive tuning. An examination of equation (7) shows that the effect on the absorption of waves caused by an increase in the di-electric constant of the air is, as a rule, unfavourable.

(*b*) The greater humidity of the surface of the earth during fog must, generally speaking, increase the range. This explanation cannot, however, account for the beneficial effect experienced when telegraphing over the sea during foggy conditions.

(*c*) It is a fact *that the conductivity of the air during fog is extremely small.* The absorption of the waves must therefore be less in foggy than in clear weather, but this (*vide* Section 11) is of no great practical significance. It is highly probable that in consequence of the low conductivity of the air the discharges from the antenna are greatly reduced. The reason for the favourable effect of fog must probably be sought in this, and also perhaps in the protection which the fog affords against discharges caused by solar rays.

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13. *Passage between Water and Land.*

It is easy to see that a plane wave passing from water to land, and the reverse, must suffer a partial reflection. The amplitude of a wave at any point is conditioned not only by the distance which the wave has travelled over land and sea, but also by the form of the shore. In this, perhaps, lies an explanation of the frequently-observed phenomenon, that better effects are sometimes obtained at stations far removed from the sending station than at nearer stations.

NOTES AND COMMENTS.

The Buda-Pest Technical Conference.

The present number contains a report of the proceedings of the first International Conference of Government Telegraph and Telephone Technicians, held at Buda-Pest in September last. A preliminary announcement appeared in our issue of October, but the date of going to press precluded the possibility of furnishing any details of the Conference itself.

Such an event calls for more than passing comment, as it most probably inaugurates a permanent system of closer co-operation among the technical officers of the various state administrations than has ever before been found possible. Such co-operation can be founded on no surer basis than that of personal friendship, and it is a great pleasure to be able to record that this first conference has contributed most powerfully to that condition by the establishment of relations of cordial fraternity among numerous representatives of the leading telegraph and telephone services of Europe.

On witnessing the inception of such a wide-reaching organisation, one naturally asks, What is its *raison d'être* and its scope? The answer is simple. The primary object of the conferences is the discussion of the more important and difficult technical problems of general interest to our profession which await solution. Although the technical literature of to-day is rich and voluminous, there are numberless points of great practical importance which fail to find expression in magazine articles, and which can only be brought out and made to yield their full significance in the more free and ready conditions of personal intercourse, where the light and shade of opinion and experience from many different sources is available. Even the most advanced administration has much to gain from knowledge of the progress and invention of others, and it is remark-

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able to what an extent the problems with which each different country is confronted are found to have their counterpart in the general experience of all.

It is not desirable, nor is it proposed, that these conferences shall be strictly official in character; their objects are solely the furtherance of personal intercourse, and the discussion of technical matters of practical bearing; the results of their deliberations are not in any sense binding upon any administration which participates. Neither is it desirable that they should resolve themselves into meetings for the consideration of questions of general electrical science or the presentation of theoretical treatises; such matters may well be left to the medium of the technical press. The utility of the conferences can only be maintained, and their success assured, by the concentration of attention upon matters of practical importance tending towards the solution of the increasingly difficult technical problems which confront our engineers. In this direction the conferences will result in placing the accumulated knowledge and skill of the combined administrations of Europe at the disposal of every one of them, and in making common property of the latest developments and improvements, no matter where they may have originated.

The individual with an axe to grind must be carefully excluded. It is not an easy matter to draw the correct line in this respect, but the respective administrations can, no doubt, be trusted to provide adequately against any improper exploitation of the conferences without excluding any contributions of real value or interest.

Our services, dealing as they do with national and international systems of communications, are happily free to a remarkable extent from anything in the nature of conflicting interests. They do not compete one with another, their objects are identical, and the prosperity and efficiency of one contributes directly to a like condition in all.

The fact that the recent Conference was confined to representatives of European nations suggests the inquiry whether future Conferences might not be framed to embrace a wider sphere. Is the co-operation of America too much to hope for? It is true that in the United States there is no Government service of Telegraphs or Telephones, but we cannot recognise any difficulty from that standpoint. The services are organised on a truly national scale and have much to teach, without perhaps excluding the possibility of something to learn. We may therefore be permitted to hope that in the years to come it will be found that not only the nations of Europe, but the United States, the British Colonies and many others may participate from time to time in a great world's Congress of Telegraph and Telephone Engineers. The days of Esperanto are not yet effectively with us, and in a polyglot assembly the

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language question has its difficulties. Even the recent limited Conference had the defect of being bi-lingual. It was originally understood that the proceedings would be wholly in French, but it was found that some very interesting papers were read and partly discussed in German. As all, except some of the German-speaking delegates, adopted French as their medium of expression, we think it would be well to have a definite understanding on this point, and as French is the generally accepted international language, it naturally suggests itself as the most suitable language for future conferences.

Coming now from the general to the particular, we have placed before our readers a summary of the proceedings of the first conference which will fully illustrate its character and scope. A large number of papers of an important and interesting nature were read and discussed. These have been printed by the Hungarian administration, with abridged discussions, etc., and form a large-sheet volume of 400 pages. Even this wealth of material cannot be taken as representing the technical value of the Conference; the informal exchange of views among delegates with common interests in particular directions is, we think, a factor of even greater importance in estimating results. The difficulties associated with the organisation of a conference of this magnitude for the first time can readily be imagined, and it only remains to say that these difficulties were surmounted in the most admirable, and, indeed, triumphant manner by the Hungarian officials. The supplementary programme of excursions and visits of inspection which they had drawn up combined technical information and pleasurable interest to a unique degree. It is safe to say that few of the delegates can point to a period more full of rich experiences, and that all of them will look back to the time spent at Buda Pest as among their pleasantest recollections. The sympathetic co-operation of many outside organisations, educational, industrial, and social, had been enlisted in the service of the Conference, and the project was especially fortunate in having secured from its inception the powerful and enthusiastic support of the Hungarian Minister of Commerce, François de Kossuth, a worthy son of a famous sire. Monsieur de Kossuth's kindness and encouragement will not readily be forgotten. And what can we say of our hosts themselves, of the colleagues who so spontaneously undertook the labour of organisation, save that their unbounded hospitality and courtesy adequately reflected the well-known characteristics of their charming nation. In such a case it would be invidious to select any individuals for special praise; all according to their opportunities worked indefatigably for the common good. To Monsieur Kolossváry, the technical director of the service, fell the important position of President of the Conference,

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an office which he discharged with unvarying tact and discretion. The British Administration was honoured by the election to the vice-presidential chair of Major O'Meara, who, in Monsieur Kolossváry's absence, presided most acceptably over several meetings of the Conference.

Special thanks are due to the Hungarian Society of Engineers and Architects, who so kindly placed their handsome and commodious premises at the entire disposal of the Conference, and to the principals of the many manufacturing firms, who not only opened their works for inspection, but displayed an amount of attention and hospitality which were truly remarkable. Chief among them, perhaps, we recollect our visit to the copper working establishment of Messrs. Weiss & Co., a steamboat trip of five or six miles down the river. Not only were we met by the *usual* lavish decorations, but a special floating landing-stage had been constructed to save us the trouble of getting ashore in small boats. From this a highly decorated avenue, lined by the firm's employees, led to their large and interesting works. Many hours were spent in inspecting the various processes, in viewing a turn-out of the fire brigade, and in amply attending to the wants of the inner man. On sallying forth once more we found the way to the river, marked out by hundreds of men with torches, who after our departure ranged themselves along the shore and waved a picturesque farewell in response to the strains of our orchestra. When our good little ship had once more brought us back to the myriad lights of Buda, the noble façade of the Royal Palace was found to be brilliantly illuminated at every window. What the imperial function was we know not, but our general frame of mind was such that this also was unhesitatingly hailed as a tribute to the Conference.

At the final meeting the question of the next Conference was discussed, and it was decided that it should be held in 1910. An international committee was appointed to settle the place of meeting, and to select the most suitable subjects for consideration and discussion.

T. F. P.

Institution Meetings.

A FULL report of the Meeting of the Institute which was held on November 9th and which was attended by the Postmaster-General is given on other pages, and will, we feel sure, be read with great interest. The little function of presenting the medals was carried through very gracefully by Mr. Buxton, and the successful authors were heartily applauded by their colleagues.

Both Mr. Buxton and Major O'Meara took occasion to give expression to appreciative criticism of the Institute and its work, and

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their remarks cannot fail to encourage those officers who spend much of their time on work of this nature. It cannot be too fully realised that the Institute has not attained to its present dimensions without a large amount of labour by its many officers, and it may be good for them to know that their work is not entirely unseen.

After the presentation Mr. Buxton remained for some time listening to the reading of Mr. Henley's paper on "The Examination of Wrought Timber." It is a pity that the paper for the evening was not one more intimately connected with the main line of our work, and it is perhaps fortunate that Mr. Buxton did not remain to hear the discussion. But few of the speakers brought any further light to bear on the subject, and most of them had carefully scanned the paper so as to be able to point out omissions. Several seriously exceeded the time limit, thus prolonging the discussion to the point of tediousness.

The severely critical point of view which has been adopted by many of the speakers at these meetings will not tend to encourage the production of further papers, as the task seems to be a thankless one.

We sincerely hope that all concerned will unite in an effort to introduce a different atmosphere into the proceedings. Comments of a personal nature, and especially when of an undignified character, should be rigorously repressed, and all should endeavour to make the meetings an opportunity for the interchange of opinions and friendly counsel. One other suggestion: Why should not the Chairman have the support of the Committee on the platform? This course is usual at other meetings of a similar kind and tends in the direction of giving dignity to the assembly.

Colonial Notes.

We have been favoured by Mr. J. K. Logan, Superintendent of Electric Lines for New Zealand, with copies of the New Zealand Postmaster-General's recent reports, and also with an advance copy of the mileage return for the official year ended March 31st, 1908. We have printed the last-named in full, and several extracts from the former which will, we think, interest our readers as showing the state of affairs in the Colony which has earned so great a reputation for progressiveness.

We would draw the attention of our readers to three paragraphs: (1) The regulation as to a minimum salary for married officers, which practically puts a premium on marriage; (2) the restrictions as to the use of the telegraphs for betting purposes; and (3) the decision to supply typewriters for the use of telegraphists when receiving messages.

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In connection with the latter it will be remembered that our first number contained an article describing the use of the typewriter for this purpose in the United States.

Our First Volume.

This number completes our first volume, and it is perhaps a fitting occasion on which to depart from the reserve which has hitherto characterised our editorial pronouncements, and take our readers into our confidence as to the health and progress of the year-old infant.

Commenced with a list of 600 subscribers it was thought a bold step to order 1000 copies of No. 1, but two reprints were necessary, and so great was the demand for the Journal that for Nos. 2 and 3 3000 copies were printed. Letters of kind commendation and encouragement have been received in generous plenitude, not only from the homeland, but from all over the world, and we have been made to realise that the desire for such a linking-up medium as the Journal provides, was much greater than we had estimated.

While much has been accomplished, we do not wish it to be understood that we have reached our ideal. We have not. We hope from time to time to introduce new and better features, and to make the Journal more worthy of the great and dignified profession which it strives to represent. To attain that end, however, it is essential that we have the assistance of our readers, and especially of the members of the Institution. The Journal should be much in their minds, and they should keep alive to every new experience in order that they may relate it through the Journal for the benefit of their comrades. The life of an engineer is full of interesting events, but the great majority of them pass unrecorded. This need be so no longer, and we will look forward to vol. 2 in the hope that we shall have the pleasure of discovering other new writers who will aid us no less willingly and ably than those who have contributed to the success of No. 1.

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STAFF CHANGES.

BRITISH POST OFFICE. ENGINEERING DEPARTMENT.

PROMOTIONS.

District.	Name.	Appointment.	Previous Service.
E. in C.O.	Mountain, W. S.	Prin. Clk.	Tel., Manchester, 1885; Jr. Clk., Engr. Dept., 1892; Draughtsman and Shorthand Writer, 1895; Cl., 2nd Cl., 1898; 1st Cl., 1903.
E. in C.O.	Freeman, S. M.	Clk., 2nd Cl.	Tel., C.T.O., 1895; Exr., 2nd Cl., T.S.O., 1898; Clk., 3rd Cl., Engr. Dept., 1902.
E. in C O.	Hardham, H. A.	Clk., 2nd Cl.	Tel., C.T.O., 1893; Jr. Clk., P.S.D., 1901; Clk., 3rd Cl., Engr. Dept., 1902.
E. in C.O.	Longheed, W.	Clk., 3rd Cl.	Sr., L.P.S., 1903.
E. in C.O.	Regan, D.	Clk., 3rd Cl.	Sr., L.P.S., 1902.
E. in C.O.	Rogers, F.	Clk., 3rd Cl.	Sr., L.P.S., 1903.
E. in C.O.	Spottiswoode, D.	Clk., 3rd Cl.	Sr., L.P.S., 1905.
E. in C.O.	O'Conner, D. J.	Clk., 3rd Cl.	Sr., L.P.S., 1903.
E. in C.O.	Maguire, J. J.	Clk., 3rd Cl.	Sr., L.P.S., 1904.
E. in C.O.	Bayly, A. E.	Clk., 3rd Cl.	Asst. Clk., S.B.D., 1903; Clk., 2nd Div., 1904; Clk., Factories, 1907.
E. in C.O.	Hart, A. B.	Engr., 1st Cl.	Tel., Cambridge, 1893; Ju. Clk., Engr. Dept., 1896; Clk., 3rd Cl., 1898; Engr., 2nd Cl., 1901.
E. in C.O.	Fraser, J.	Engr., 1st Cl.	Tel., Aberdeen, 1877; Relay Clk., Engr. Dept., 1896; Engr, 2nd Cl., 1901.
E. in C.O.	Stevenson, B. J.	Engr., 2nd Cl.	Tel., Edinburgh, 1895; Sur. Sta. Clk., 1902; Clk., 3rd Cl., Engr. Dept., 1903.
E. in C.O.	Anson, B. O.	Engr., 2nd Cl.	Tel., Hull, 1896; Clk., 3rd Cl., Engr. Dept., 1903.
E, in C.O.	Ramsay, F. G.	Engr., 2nd Cl.	3rd Navg. Offr., "Monarch," 1905; 2nd Navg. Offr., 1906.
Suptg. Engr. Offices, London	Kirby, J. W..	Clk., 2nd Cl.	Tel., C.T.O., 1887; Ju. Clk., Engr. Dept., 1899.
Suptg. Engr. Offices, London	Brockett, A. W.	Clk., 2nd Cl.	Tel., C.T.O., 1886; Ju. Clk., Engr. Dept., 1900.
E. in C.O. (Cable Ship "Monarch")	Hutchons, E. R.	Second Navg. Officer.	1907.

RETIREMENTS.

E. in C.O.	Harrison, T..	Suptg. Engr.	M.T. Co., 1861; P.O., Hull, 1870; Insp., Engr. Dept., 1880; Asst. Suptg. Engr., 1896; Suptg. Engr., 1901.
E. in C.O.	Jarvis, P.	Engr., 1st Cl.	Tel. Manr., 1879; Ju. Clk., Engr. Dept., 1882; Senr. Clk., 1890; Engr., 2nd Cl., 1895; 1st Cl., 1902.
E. in C.O.	Cullen, J.	Engr., 2nd Cl.	1871; Engr., 2nd Cl., 1888.
E. in C.O.	Bell, H. S. T.	Engr., 2nd Cl.	Tel., Belfast, 1875; Dublin, 1881; Relay Clk., Engr. Dept., 1887; Engr., 2nd Cl., 1892.
E. in C.O.	Ogden, H.	Clk., 3rd Cl. (Suptg. Engr. Office).	S.C. and T., Liverpool, 1893; Clk., Engr. Dept., 1902.

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DEATH.

District.	Name.	Appointment.	Previous Service.
E. in C.O.	Coakley, J. T.	Clk., 3rd Cl. (Suptg. Engr. Office).	Sr. Cir. Offr., 1898; Asst. Clk., S.B.D., 1899.

TRANSFERS.

Name.	Rank.	District. From.	District. To.
Moir, A.	Suptg. Engr.	I. S.	Met. S.
Whitehead, J.	Engr., 1st Cl.	Met. N.	E.
Eames, E. J.	Engr., 1st Cl.	Met. C.	S. (R.E.)
Haynes, J. H.	Engr., 1st Cl.	Sc. E.	S. (R E.)
Partridge, G. N.	Engr., 1st Cl.	Met. C.	S. Wa.
Vooght-Cornish, H.	Engr., 1st Cl.	E. in CO.	E. L. and P.
Billingham, G. W.	Engr., 2nd Cl.	N.W.	E. in C.O.
Hook, G. H. J.	Engr., 2nd Cl.	N.M.	E. in C.O.
Horton, F. D.	Engr., 2nd Cl.	Sc. E.	E. in C.O.
Baxter, J.	Engr., 2nd Cl.	N. Wa.	E. in C.O.
Bramwell, J. T.	Engr., 2nd Cl.	N.W.	E. in C.O.
Partridge, T. T.	Engr., 2nd Cl.	S. Wa.	E. in C.O.
Simmance, J. H	Engr., 2nd Cl.	Met. C.	E. in C.O.
Picker, H. F.	Engr., 2nd Cl.	Sc. E.	E. in C.O.
Bassett, S. W.	Engr., 2nd Cl.	S.M.	E. in C.O.
Giles, H. W.	Engr., 2nd Cl.	N. Wa.	E. in C.O.
Sanger, P. M.	Engr., 2nd Cl.	Met. C.	S. (R.E.)
Hammond, G. W.	Sub-Engr.	N.E.	E. in C.O.
Leigh, C.	Sub-Engr.	N.E.	E. in C.O.
Gibbon, A. O.	Sub-Engr.	E.	E. in C.O.
Fletcher, J. E.	Sub-Engr.	N.	E. in C.O.
Waller, J	Sub-Engr.	Met. C.	E. in C.O.
Hay, C. E.	Sub-Engr.	Met. C.	E. in C.O.
Lock, F.	Sub-Engr.	N.W.	S. Wa.
Jack, J. A.	Sub-Engr.	I. S.	Sc. W.
Hansard, A.	Sub-Engr.	Sc. W.	I. S.
Coxon, J.	Sub-Engr.	E. L. and P.	E. in C.O.
Morgan, J. A.	Sub-Engr.	Met. N.	E. in C.O.
Colthurst, H. W.	Clk., 3rd Cl.	N.E.	I. N.
Betts, G.	Clk., 3rd Cl.	N.	N.E.
Jackson, R.	Clk., 3rd Cl.	Met. S.	Met. N.
Camp, A. W. K.	Clk., 3rd Cl.	Met. C.	Met N.

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FOREIGN AND COLONIAL NOTES.

DOMINION OF NEW ZEALAND.

Summary of miles of line, miles of wire, number of offices, number of Exchanges, number of subscribers and extension telephones connected to Exchanges, miles of Exchange wire, and knots of cable laid for year ending 31st March, 1908.

DISTRICT.	Miles of Line.	Miles of Wire.	Number of Offices.	Number of Exchanges.	Number of Subscribers, including Extension Telephones.	Miles of Telephone Wires erected, including Metallic Circuit.	Submarine Cables, length in knots.
	m. ch.	m. ch.				m. ch.	
Auckland . .	2,402 30	6,555 60	374	11	4,077	5,403 18	20·523
Wellington . .	2,477 39½	9,256 22½	425	44	9,896	7,770 63	293·739
Nelson . .	1,411 69	3,043 15	230	9	1,416	652 23	10·660
Christchurch .	1,180 57	4,155 48	234	21	4,111	4,126 7	1·518
Dunedin . .	2,182 60	5,732 60	340	26	4,381	4,048 38	25·101
	9,655 15½	29,343 45½	1603	111	23,881	22,000 69	351·541
Totals, Mar., 1907	8,953	27,031 0	1446	105	19,882	12,921 10	297·013
Increase for 1908	702 15½	2,312 45½	157	6	3,999	9,079 59	54·528
Percentage . .	7·27	7·88	9·79	5·40	16·74	41·26	15·51

EXTRACTS FROM POSTMASTER-GENERAL'S REPORT DATED JUNE 22ND, 1908.

STAFF.

"The Post and Telegraph Classification Act, 1907," makes important changes in the classification of officers of the Department. Instead of there being twenty-five classes, some identified by number and some by name below the First Division, the Department has now thirteen classes. This in itself makes greatly for simplification of treatment of the scheme of classification; but when it is considered that the former distribution of officers interposed arbitrary reasons to keep apart officers doing work of the same relative importance and value for the Department, the amelioration appears still more clearly. For instance, officers of the First Grade in the First Class and Chief Postmasters at the four principal centres were formerly separated, and some slight difference in salary marked the separation. The separation was purely arbitrary, and hampered the Department in filling vacancies. Now these Chief Postmasters come into the scheme in line with other officers doing work of equal importance, and the title "First Grade" and its limits of salary cover all. This will have the effect, it is believed, of enlightening and contenting officers. The same reasons have dictated the fusion of following classes, and will no doubt produce the same results.

An Order in Council renewing Classification Regulations was made on the 29th July, 1907, with effect from the 30th July, 1907. Among changes made were the following:—An educational certificate of proficiency is required from applicants for employment in the Clerical Division. The age for appointment to the Clerical Division was reduced from sixteen to fifteen years. Experts may be appointed at an age over twenty years. An officer who joined the Department before the passing of the Post and Telegraph Classification and Regulation Act of 1890 is not now required to pass the senior examination before receiving promotion to any class higher than the Fifth Class (£190—£250), (by a later Order in Council, of May 2nd, 1908, the Sixth Class—£200—£260), also persons skilled

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in electricity or telegraphy, or in literature, science, or art, to the satisfaction of the Minister, are not required to pass any further examination other than the usual departmental ones. Any person over thirty-five years of age who has been temporarily employed previous to reaching such age, and whose employment has been continuous, is eligible for appointment to the Non-clerical Division. Power is given the Ministers to fill vacancies requiring, in his opinion, special experience or special knowledge, in the most suitable way, regardless of seniority of officers. Officers transferred in the same financial year to any *grouped* class retain the same relative positions as before such transfer. Female officers are granted the same periods of leave as male officers. Non-clerical officers of ten years' service and upwards receive three weeks of annual leave instead of two weeks. Cadets passing an examination in shorthand are granted six months' seniority. Examinations in departmental requirements are specified for postal and telegraph officers and cadets.

Every male officer who is married, or who is a widower with a child or children, is to receive a salary of not less than £130. But he is not entitled to claim, and may not be paid, the additional sum of £10 mentioned in the next paragraph until the salary attached to his official position in the Post and Telegraph Departmental List reaches £130. Any sum representing the difference between the salary attached to his official position and a salary of £130 is regarded as a gratuity only.

An officer who is married, or is a widower or a widow with a child or children, and is drawing a salary less than £150 per annum, is paid a sum additional to salary of £10 per annum until the salary reaches the sum of £150 per annum. When the difference between the annual salary and £150 is less than £10, a sum equal to the difference only is paid.

Officers in the Second, Third, and Fourth Grades of the Twelfth Class who have been fifteen years or upwards in the service of the Department, if favourably reported upon in regard to conduct and efficiency, may be granted, at the discretion of the Minister, good-conduct money at the rate of 6*d.* per day.

An efficiency test, as provided for by the Classification Regulations, applying to Post and Telegraph officers before receiving salary in excess of £165 per annum, and a further efficiency test, applying to Postal officers, and a technical examination applying to Telegraph officers before receiving salary in excess of £200 per annum, took place in April—May, 1908, at which also the results were satisfactory.

Telegraphs.

The charge for ordinary Press telegrams transmitted on departmental holidays for evening papers was reduced from 1*s.* to 6*d.* from the 19th August, 1907, for each hundred words or fraction thereof.

Telegrams in plain language relating to betting or to investments on the totalisator or in coded language reasonably supposed to relate to betting or to investments on the totalisator are forbidden by "The Gaming and Lotteries Act Amendment Act, 1907," to be delivered on any racecourse. Money-order telegrams addressed to a racecourse are refused. Telegrams or money-order telegrams addressed otherwise than to a racecourse are accepted, even though they relate to betting.

Typewriters for receiving telegrams have been in use for some years now, but their use has been confined to a few officers who supplied their own machines. It has been decided to supply at an early date a number of typewriting machines for the use of officers receiving telegrams, and to make a special payment to the officers selected to use them. Officers who at present own their machines may sell them to the Department.

The telegraph receipts for the financial year, including telephone-exchange subscriptions, private-wire rents, etc., amounted to £344,251 0*s.* 6*d.*, compared with £307,520 15*s.* 11½*d.* in 1906–7, an increase of £36,730 4*s.* 6½d., or 11·94 per cent.

The expenditure was £357,581 1*s.* 3*d.*, as against £291,359 12*s.* 6*d.* for the previous year, an increase of £66,221 8*s.* 9*d.*, or 22·73 per cent.

There were 9656 miles of line and 29,344 miles of wire at the close of the year—an increase of 703 and 2313 miles respectively.

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The net expenditure out of Public Works Fund for telegraph-extension was £155,491 8s. 6d., as compared with £114,067 19s. 9d. in 1906-7.

The number of private wires and subsidised lines was 389, compared with 351 in 1906-7. The amount received for rent, maintenance, etc., was £2205 6s. 4d., as against £2123 3s. 8d. in 1906-7.

The total number of telegraph and telephone offices open at the close of the year was 1611. Of these, 280 were telegraph offices and 1331 were telephone offices.

The number of telegrams of all codes forwarded during the last financial year was 7,042,923, an increase of 646,591, or 10·11 per cent. over 1906-7.

The proportion of paid telegrams per head of population was 7·42, and 6·84 the previous year.

The number of ordinary telegrams forwarded was 5,040,044, of the value of £159,244 3s. 7½d., compared with 4,548,532, of the value of £148,659 5s. 3½d. in 1906-7, an increase of 491,512 and £10,584 18s. 4d.

The urgent telegrams numbered 255,525, of the value of £15,621 13s. 2d., an increase of 19,794 in number and £1281 14s. 10d. in amount.

The average value of each ordinary telegram was 7·58d., and of each urgent telegram 1s. 2·67d.

452,536 Press telegrams, of the value of £21,201 8s. 1½d., were forwarded in 1907 8, as compared with 389,917, valued at £18,089 1s. 4d., forwarded in 1906-7—an increase of 62,619, or 16·06 per cent., in number, and an increase of £3112 6s. 9½d., or 17·2 per cent., in value.

The value of each Press telegram averaged 11·24d., as against 11·13d. in 1906-7.

The bureau messages numbered 1,210,174, of the value of £26,858 13s. 6d., as compared with 985,900, of the value of £21,212 15s. 6d., in 1906-7—an increase of 224,274 in number and £5645 18s. in amount.

The average value of each bureau message was 5·33d., as against 5·16d. in 1906-7.

Wireless Telegraphy.

The first message by wireless telegraphy despatched from New Zealand to an oversea country was transmitted on the 3rd February, 1908, from the Prime Minister of this Dominion to the Hon. Alfred Deakin. The message was despatched from H.M.S. "Pioneer," at Wellington, to H.M.S. "Psyche," in Port Jackson, the battleship "Powerful" acting as "repeater" at sea within twelve or fourteen hours' steaming-distance of Sydney. The interval of time between losing the New Zealand signals and picking up the Australian was six hours.

Telephone Trunk Wires.

The demand for telephone trunk wires to connect outlying places with exchanges and the exchange in one locality with that in another does not diminish. In most cases telegraphic communication exists between the towns, but this does not always satisfy the public. A perusal of the record of works carried out in the different Inspectors' districts will show that much has been done during the year to meet these requirements, and the general extension of the telephone system has been on a scale in excess of the extension in previous years.

As stated in former reports, the carrying-capacity of a telephone circuit is limited to about fifty spoken communications a day, so that the growing requirements of the public for telephonic facilities between centres of population can only be met by a large capital outlay. Telegraph revenue shows a tendency to shrink where telegraph and telephone communication exist side by side.

The superimposed circuits introduced from time to time work satisfactorily, and wherever facilities exist in connection with new wires telegraph circuits are, when considered advisable, superimposed upon the new wires.

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STUDENTS' SECTION.

In this section, so far as space allows, answers will be given to any questions of general interest from an educational point of view. Queries should be addressed to Mr. A. W. Martin, Engineer-in-Chief's Office, G.P.O. West, E.C.

Question 1.—Find the number of lines of force developed in a round bar of iron 18 cm. in length, 0·5 sq. cm. in cross section, and having a permeability of 150 if the current strength be 250 milliampères and the number of turns of wire 500.

Answer.—The number of lines of force through the iron is called the magnetic flux.

$$\text{Magnetic flux} = \frac{\text{magneto-motive force}}{\text{reluctance}}$$

$$= \frac{\frac{4\pi C n}{10}}{\frac{l}{a\mu}}$$

Where C is the current strength in ampères,

n ,, number of turns of wire,

l ,, length of the iron in cms. assumed to be evenly covered by the coil of wire,

a ,, sectional area of the core in sq. cms.,

μ ,, permeability of the iron,

$$\text{Magnetic flux} = \frac{\frac{4\pi \times 0{\cdot}25 \times 500}{10}}{\frac{18}{0{\cdot}5 \times 150}}$$

,, = 654·5 maxwells.

This method of determination is only approximately correct in the case of a bar whose length is twenty times as great as its diameter. For greater lengths than twenty diameters the formula is more applicable and for lesser lengths there is no general solution.

Question 2.—A copper disc of 10 cm. radius revolves 300 times per minute in a plane at right angles to the horizontal component of terrestrial magnetism (H). Find the potential difference between the rim and the centre of the disc assuming H = 0·18.

Answer.—(2) When any conductor moves so as to cut 10^8 magnetic lines of force per second an E.M F. of one volt is produced in it. The disc may conveniently be regarded as consisting of an infinite number of radii joined in parallel and the E.M.F. produced is that set up in any one radius. It is therefore necessary to find the number of lines cut by a radius in one second.

Let r be the radius of the disc in cms.

,, n ,, revolutions per second.

Lines cut per revolution = $H \pi r^2$

,, ,, second = $H \pi r^2 n$

$$\text{P.D. in volts} = \frac{H \pi r^2 n}{10^8}$$

$$= \frac{0{\cdot}18 \times \pi \times 10^2 \times \frac{300}{60}}{10^8}$$

$$= \frac{283}{10^8} \text{ approx. or } 2{\cdot}83 \text{ micro-volts.}$$

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LINE CONSTRUCTION WORKS.

THE following figures are indicative of the extent of the open line construction works which have been carried out in the provinces during the past four months:

	Approximate number of poles erected.	Approximate number of miles of wire erected.
July	2800	1500
August	3070	1770
September	3020	1902
October	2900	2190

These figures include upwards of 2000 H Poles, which are counted as one pole each. Minor works and ordinary renewals are omitted.

The number of skilled workmen and labourers employed in October, exclusive of those employed in the Metropolitan districts, were approximately 1620 and 3680, which is an increase of about 30 per cent. on the number of men employed on construction work in November, 1907.

PROFESSIONAL PAPERS.

READERS are politely requested to peruse the particulars of professional papers on page 2 of cover.

INSTITUTION NOTES.

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS.

ON Monday, November 9th, 1908, the Rt. Hon. Sydney Buxton, M.P., H.M. Postmaster-General, officiated at St. Bride's Institute, Ludgate Circus, at a special meeting of the Post Office Electrical Engineers' Institution, and presented medals to the gentlemen whose papers, delivered in 1906, had been adjudged by the Council to be of highest merit.

The Engineer-in-Chief, Major W. A. J. O'Meara, C.M.G., presided, and said he knew it was the desire of the meeting that he should express to the Postmaster-General on their behalf a most hearty welcome, and say how much they appreciated the great interest shown in them by coming to present the medals when he was so full up with engagements. The medals were awarded in connection with the first session of 1906-7, and there might be some who questioned the wisdom of presenting medals, and who might think that engineers should take sufficient interest in their profession, and not look for the award of a medal. It was true that papers would be prepared and read in any case, but he thought it was only right that medals should be presented. If these awards did nothing else they had the very beneficial effect that they helped the members of the Institution to see the standard at which the Council was aiming, that is to say, the standard of excellence, and it was for this reason that he was glad of the presentation of the medals. He hoped that when the Council got into its stride, it would see its way to promote the interests of the Department in other ways. For instance, the Council might decide that it would be a useful thing to institute a special medal for presentation

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each year in connection with the solution of important problems which from time to time may perplex the Department. That is to say, the Council would invite essays from the members of the Institution on some definite subject, and award the special medal to that member who provided the best solution.

Major O'Meara stated that he would not that evening attempt to describe the extent of the field covered by engineering. On Tuesday last the new President of the Institution of Civil Engineers had given some indication of the field which was covered by the engineers who dealt with problems connected with transport alone, and was justly proud of the achievements in this field. They, as communication engineers, were glad that in their small way they probably had assisted in the realisation of the projects on which the transport engineers had been engaged. Without the electric telegraph there could be no trains at sixty miles an hour; without the electric train staff it would not be possible to utilise single line railways to their fullest capacity; without the electric telegraph between the bridge of a ship and its engine-room the captain would not possess the power easily to manœuvre his vessel.

He said that the Postmaster-General had expressed the desire that the P.O. engineering enterprises should be conducted on a commercial basis. The P.O. engineers welcomed this proposal; nothing would give them greater pleasure than to play the same part in the engineering enterprises of the P.O. that the members of their profession played in commercial organisations. Lest unfortunately an impression might prevail that the engineers of the P.O. were not interested in the financial side of their work, not only would he draw attention to the fact that papers on the commercial aspect of P.O. engineering had been read before this Institution, but he would also like to draw attention to Appendix R, page 96, of the Postmaster-General's 'Annual Report' for 1908, where it was shown that the maintenance of the telegraph system in 1898-9 cost £617,616, and had increased in the year 1903-4 to over a million, but since then the expenditure had decreased so that in 1906-7 it was £947,657. The period of the decrease synchronised with that during which the P. O. engineers had become and remained responsible for their own accounting. The estimated expenditure for the present year has again gone up to over a million, but this could be accounted for by a reference to page 31 of the Report, where it was shown that various increases of pay had been granted as a result of the Report of the Select Committee of the House of Commons under the presidency of Mr. Hobhouse.

He then went on to say that there may be some who might ask what has accounting for engineering expenditure to do with engineers? His answer to this question could be given in words very similar to those used by the President of the Institution of Civil Engineers on Tuesday last. It has as much to do with them as the consideration of the materials used by them has to the design, user, and efficiency of the mechanism of the telephone switchboard in which these materials are used.

Major O'Meara then asked Mr. Buxton to present the medals.

The Postmaster-General apologised for his martial attire, stating that he was going to the Guildhall to defend his country against suffragettes and other people. He had much pleasure in accepting the invitation to present the four medals, and congratulated the Institution on its accomplishments, stating that he had followed its efforts since its inception. He was glad to think that the Department had given it encouragement. Referring to the increase in membership, he thought its rapidity augured well for the future of the Institution. He thought everyone would agree that an Institution of this sort was an advantage both for the officers concerned, for the Department, and thus also for the public at large, and one of the most interesting features about it—he thought the most satisfactory feature—was the great interest which had been taken in the various papers which had already been read in the various branches throughout the country. The great variety of papers on various abstruse questions showed the interest taken, and the discussions which followed the reading of the papers showed that the members took an interest in the various addresses, which were rather Greek to him.

From time to time he went round to visit the various post offices and the various telegraph stations and telephone stations in London and elsewhere. He had the matters

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explained to him, and he always looked very wise and said as little as possible. He thought that all would agree with the Chairman that an Institution of this sort was certainly of great help to those who were engaged in the difficult and complicated work of P. O. engineering, and it provided a kind of co-operative education for the whole of them. He thought that it had a great future before it, since its educating effects would help the officers to advance in knowledge. Looking to the fact that engineering is the one branch of the Postal Service in which there are changes from year to year, he thought the Institution would help to keep the Department abreast of the times, and not allow it to fall behind outside engineering works in the various matters of telephone construction, wireless telegraphy, etc.

Mr. Buxton referred to the additional responsibilities and work which would fall on the P. O. engineering staff when they had all the telephones of the country to maintain in three years' time or possibly sooner. He said that the engineering work was at present increasing more rapidly than they could secure additional staff. This was unfortunate, and he quite realised that many of the engineering staff were over-burdened with work. There was necessarily some delay in obtaining additional staff owing to the necessity for seeking Treasury sanction, which took some little time. He said that the matter was being carried through as quickly as possible, and the subject of a revision of the Engineering Branch was in hand. The delay was solely owing to the physical difficulty of arranging such matters.

The Postmaster-General mentioned that the Institution had a very excellent library, and he was glad to hear from the Secretary that it was used to its fullest extent. Owing to the large number of books recommended to the library the task of choosing the books to be purchased was very difficult, and consequently many suggestions had to be rejected. He said that he could not obtain the acceptance of his book on fishing, yet he assured them that from the scientific, from the mental, or from the physical point of view it was much better than even engineering works.

He then went on to mention that the Institution was extending its membership to foreign and colonial engineers. He said that this was a good thing, as it tended to improve international relationships. He mentioned that engineering was doing much in this direction, and instanced the recent International Conference on Electrical Units, at which Major O'Meara represented the Post Office.

Mr. Buxton was pleased to have the honour of presenting the medals. The recipients, whose names are given below, were in each case congratulated by Mr. Buxton on their achievements, and heartily applauded by their colleagues.

Senior Division, Silver Medal.—Mr. J. E. Taylor for a paper on the "Propagation of Electro-Magnetic Waves"

Senior Division, Bronze Medal.—Mr. J. G. Hill for a paper on "Telephone Transmission."

Junior Division, Silver Medal.—Mr. A. O. Gibbon for a paper on "Underground Construction in the Provinces."

Junior Division, Bronze Medal.—Mr. J. S. Brown for a paper on "Post Office Lamp Signalling Trunk Exchanges."

A vote of thanks to the Postmaster-General which Major O'Meara had proposed was carried with hearty acclamation, and the meeting turned its attention to a paper by Mr. F. L. Henley on "The Inspection of Wrought Timber."

COUNCIL NOTES.

A meeting of the Council of the Institution was held at Shrewsbury on the 23rd September, 1908. Mr. A. J. Stubbs presided, and, from the large volume of business transacted, the following items of general interest have been extracted.

Colonial and Foreign Corresponding Members.

A supply of forms of application for membership has been obtained, and over 250 forms distributed to various colonial and foreign administrations.

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Submarine Staff.

It has been decided to invite members of the submarine staff at Woolwich and Dover respectively to attend meetings of the Metropolitan Centre. The question of the provision of a separate Reference Library for the use of the Submarine Staff is under consideration.

University Engineering Degree.

The Principal of the London University has been written relative to the desirability of including Telegraphy and Telephony as optional subjects for the Engineering Degree of the University. The matter will be placed before the Governors at their next meeting.

Financial Position.

A report from a Sub-committee appointed to review the present financial position of the Institution was considered and adopted.

The Council have decided to effect certain economies in printing.

Date of Annual Meeting.

The Metropolitan Committee have agreed to a suggestion from the Council that the Annual General Meeting of the Institution should be arranged for a later date than has been the practice heretofore. The next Annual Meeting has been fixed for the 26th April, 1909, at St. Bride's Institute Hall, E.C.

Reprint of Rule Book.

A reprint of the Rule Book having become necessary, it has been arranged for a new issue to be obtained at once. The Rule Book will be produced in a size uniform with the other Institution publications.

Arrangements for Winter Session.

Reports received from the various local centres indicate that the interest is being well maintained.

Full programmes have been arranged at most of the centres, and in several districts a series of interesting visits to manufacturing works, etc., arranged. The Council considered that the prospect for the winter session was of a most encouraging nature. In one or two instances, owing to extreme pressure of official business and the difficulty experienced in reaching the place of meeting, full programmes have not been arranged, and in these cases it may be found possible to render assistance from headquarters. This matter is receiving consideration.

Membership.

The membership now stands as follows, viz.:

Number on Roll, March 31st, 1908		755
Resignations	2	
Deaths	9	
	—	11
		744
New members:		
Home	45	
Colonial	9	
Foreign	1	
	—	55
Total		799

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Retirement of Mr. Jarvis.

The Council regret to report that, owing to continued ill-health, Mr. P. Jarvis has been retired from the Service. The Council unanimously resolved that a letter of regret at his enforced retirement be sent to Mr. Jarvis, together with the best thanks of the Council for his past services, and that the Council's appreciation of his work be recorded in the minutes.

Arising out of this matter, the Council proceeded to fill the vacancy created, by the co-option of Mr. E. T. Titterington as the Provincial First Class Engineers' representative.

Transfer of Mr. Gibbon.

The transfer of Mr. A. O. Gibbon to the Headquarters Staff rendered his retirement from the Council necessary. In this connection it was resolved that the Council place on record their sense of appreciation of the valuable services rendered to the Institution by Mr. Gibbon, both on the Council and in Committee. As the election of Mr. Gibbon to the Council was unopposed, it was decided that a formal election take place in order to appoint a successor. (This has been done subsequent to the meeting, and Mr. Wyatt elected as the Provincial Sub-Engineers' representative.)

LOCAL CENTRE NOTES.

METROPOLITAN CENTRE.

The meetings of the Metropolitan Centre have lost nothing of their popularity during the recess, and excellent attendances have, so far, been the rule. A paper by Mr. E. W. J. Todd entitled "The Engineering Aspect of Finance" was the subject of the October meeting, and an animated discussion took place. The theme of Mr. Todd's treatise was the underlying principles rather than the detailed operations of the Department's financial system, and he strove to show, step by step, the considerations and requirements upon which the expenditure-policy of the Post Office is based. One marked result of the discussion was the general demand for a codification of the accounting *principles*—in form similar to the "Technical Instruction" series, for the better understanding of the constantly changing details of accounting work.

On Monday, November 9th, the meeting was called somewhat earlier than usual to meet the convenience of the Right Hon. Sydney Buxton, M.P., who presented the Institution medals for papers read during session 1906-7. Major W. A. J. O'Meara presided, and Mr. F. L. Henley contributed a paper on "The Inspection of Wrought Timber." Though limited in its scope the paper was of excellent quality, and the speakers who followed were for the most part of an inquiring rather than of a critical mind, criticisms being generally directed against the limits which Mr. Henley had set himself in the title of his paper. On the motion of Mr. J. W. Atkinson it was resolved that the Secretary be instructed to express to Mrs. Hertha Ayrton the deep sympathy of the Metropolitan Centre in the loss of the late Professor W. E. Ayrton, himself an old telegraph man.

Mr. S. C. Bartholomew's paper entitled "Protection from Power Circuits," which was read on December 14th, was the embodiment of much experience and careful study of the subject. Too lengthy for reading without abridgment, the paper was full of good things, and is something more than a compendium of official instructions. Mr. W. Noble presided and, as usual, a good discussion ensued.

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EASTERN CENTRE.

There was a very full attendance on the occasion of the opening meeting of the session, which was held at Cambridge on the afternoon of Tuesday, October 13th, when a paper was read by Mr. W. J. Stubbs on "Secondary Cells." The Chair was taken by the President, Mr. J. Jenkin.

Mr. Stubbs' paper dealt with the general principles of the storage cell, and explained the method of construction of the plates, the chloride cell being chosen as an example. The general arrangement of a battery room for very large cells was indicated, and the method of installing the cells detailed. Then followed an outline of the method of charging, and an explanation of the relative advantages of a shunt and a series wound machine for this purpose. The nature and treatment of the electrolyte was next dealt with, and the range of specific gravity allowable given. The maintenance of the cells including chemical tests of the purity or otherwise of the electrolyte, and the general precautions to be taken in order that the best results might be obtained were also treated at considerable length.

NORTH-WESTERN CENTRE.

The third session of the Institution, so far as the North-Western Centre is concerned, gives promise of being as equally successful as the previous ones. Six meetings have been arranged, three of which will have been held by the time this appears in print.

At the first meeting the inaugural address was given by the Vice-Chairman, the Chairman being unavoidably absent, after which an interesting paper was read by Mr. R. Cunningham entitled "Control and Discipline." At the second meeting a paper upon "Time Checks and Calculagraphs" was read by Mr. W. J. Medlyn, and proved both interesting and instructive. A working example of the time check in general use was fitted up to illustrate the paper, together with a calculagraph.

Mr. A. F. Guy will, upon the occasion of the meeting to be held on December 21st, read two short papers entitled "The Manchester Electrical Exhibition" and "Transformer Efficiencies."

The title of only one of the papers to be read at the three remaining meetings has, up to the present, come to hand, viz. "The Chemistry of Telegraph Engineering, by Mr. W. B. Smith. It may be stated, however, that the number of papers promised is in excess of the number required.

NORTH-EASTERN CENTRE.

The first meeting of the session was held on the 2nd November, when Mr. Pickering cleverly handled a paper on "Wayleave Observations" and "The New Telegraph Construction Act of 1908."

The meeting was well attended, and keen discussion followed the speaker's remarks.

Mr. Bailey is to address a meeting on the 14th December on "Some Notes on the Huddersfield Underground Work."

A visit to Messrs. Greenwood and Batley's Engineering Works has been arranged for the same day.

There is every promise of a successful session.

We are pleased to welcome the return to duty of Mr. J. Lunn after a long absence on sick leave, and trust his health is permanently established.

NORTH MIDLAND CENTRE.

The first meeting of this Centre for the present session was held on the 26th October, when Mr. T. E. Herbert communicated a paper on "The Organisation of an Engineer's Section." A general discussion followed, which proved both profitable and interesting.

The next meeting will be held on the 7th December, when Mr. G. E. Fletcher will read a paper on "Engineering Expense Accounting."

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On a date to be arranged later, Mr. W. W. Smith will contribute a paper on "Underground Distribution for Telephone Exchanges." It is hoped that it will be possible to arrange for other contributions during the session.

SCOTLAND WEST CENTRE.

Institution Meetings: Up till the present definite dates have not been fixed, and it looks as if the hand-to-mouth arrangements of last year are to be repeated. So far as results are concerned no great fault could be found with those arrangements, and it is hoped, despite the many conflicting interests, that an equally satisfactory and enjoyable session will be the experience. One of the best features of last session, socially, was the engineers' dinner, following Mr. Hetherington's paper the same afternoon. One felt invigorated by the complete relaxation afforded by the combination. The more social function in the evening undoubtedly put a top on the afternoon's proceedings, and made the day more complete and satisfying. There must be general regret, with such a pleasant memory clinging to one, that, so far, there are no indications of a repetition of that pleasure, but of course it is not too late to flame the sparks and serve up once more the genial and vivifying glow of a social evening.

As happened last session Mr. Hetherington will lead off the session's meetings, probably during the third week of December, with a paper on that important subject "Telephone Transmission."

IRELAND CENTRE.

The first meeting of the session took place on October 26th before a good attendance of members from all parts of Ireland. Mr. Sheridan, Superintending Engineer, North Irish District, occupied the chair, and delivered the opening address on the subject of "The Personal Equation."

An interesting discussion took place, in which Messrs. Fossett, Evans, Kinsey, Dwyer, and Patterson took part.

Several papers have been promised by members and the session is likely to prove successful.

NORTHERN CENTRE.

The prospects for the 1908-9 session are exceedingly good, seven papers having been promised, including two from members of the Clerical Staff.

Our first meeting was held on October 26th, 1908, when the chairman, Mr. F. Tremain, read a paper on "The Economic Aspect of Open Line Construction."

Some interesting figures, which had been obtained in connection with several large rebuilding works at present being carried out in this district, were quoted by the lecturer in support of his contention that the employment of large gangs had proved economical. A useful discussion followed.

The second meeting of the session was held on November 16th, the lecturer being Mr. T. B. Johnson, and his subject, "Protection from Power Circuits."

The lecturer dealt with his subject in a very able manner, his explanations of the different types of "guarding" being very clear. A number of diagrams illustrating these were thrown on a screen.

Considerable discussion followed, in which a large number of members took part.

Our next meeting will be held on December 14th, when Mr. J. A. Motyer will read a paper on "Paybills."

COVERS FOR BINDING.—Please see announcement on page 7 of Supplement.

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VISITS TO MANUFACTURERS' WORKS, ETC.

METROPOLITAN CENTRE.

The excellent programme of visits arranged by the Metropolitan Centre Committee under the energetic chairmanship of Mr. W. Noble, has evoked an enthusiastic if somewhat inconveniently large response. Visits have already taken place to the Stores Department Central Depôt, Messrs. Siemen's Works, and the Mount Pleasant General Factory, and the attendance has averaged nearly double the average of last year's visits.

Over one hundred members were present on Monday, December 7th, at Brook Green Works, by invitation of the Robertson Electric Lamps, Ltd. Ample arrangements had been made for the guidance of the party, and the interesting processes involved in the gradual building up of the complete lamp were most interesting. Not the least of the attractions was the huge new building, in which it is intended to accommodate 1200 employees on the manufacture of the new "Osram" lamps. The Chairman of Directors, Mr. Hirst, welcomed the visitors, and extended a similar invitation to members of the Institution to inspect the Company's other Works at Witton and Manchester. Messrs. J. W. Woods and W. Noble expressed the thanks of the members for their kind reception. South Midland and North Western Centre Committees might profitably note Mr. Hirst's remark when future programmes of visits are being compiled.

Arrangements have been completed for the following visits on the first Monday in each month:—

January.—Holloway Factory.

February.—Chelsea Power Station.

March.—Submarine Depôt and Cable Ship.

Second visit to Central Depôt Stores Department on the third Monday in January.

SOUTH WALES CENTRE.

On November 10th the members of the South Wales Centre visited the Cardiff New Exchange. Mr. Devereux conducted the assembled large party over the building, and explained the latest form of switching equipment in a very able manner.

NORTH-WESTERN CENTRE.

A visit was paid to Messrs. The General Electric Company's Works, Salford, Manchester, on the 16th and 17th October. This Company is at present engaged upon work in connection with the Glasgow new telephone installation for the Department, and the various parts of apparatus were shown to the members of the Institution.

The greatest courtesy was extended by the Company's officials, and the visitors were exceedingly interested. Two other visits are on the programme for this session, viz. to Messrs. Glover's Cable Works on the 21st and 22nd December, 1908, and to the Manchester Municipal School of Technology on the 22nd and 23rd February, 1909.

NORTH MIDLAND CENTRE.

On the 7th December a visit will be made to the British L. M. Ericsson's Company's Works at Beeston by those members who were unable to avail themselves of the opportunity last year. The managing director of these up-to-date works extends a cordial invitation for visits by members of other centres, and as every facility is given for a thorough examination such visits could not fail to be instructive.

NORTH WALES DISTRICT.

The following visits have been arranged, viz.:

December 9th—British Insulated and Helsby Cables Company, Ltd., Instrument Factory, Liverpool.

Dates not yet fixed { L. and Y. Railway Co.'s. Power Station, Formby.
Cunard R.M.S., Mauretania or Lusitania.

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LOCAL CENTRE PROGRAMMES, 1908-9.

METROPOLITAN CENTRE.

SECOND MONDAY IN EACH MONTH.

December.—"Protection from Power Circuits." Mr. S. C. Bartholomew.
January.—"Loading of Underground Circuits." Mr. A. W. Martin.
February, March.—Not yet definitely arranged.
Annual meeting of Institution, April 26th, 1909.

IRELAND CENTRE.

October 26th.—President's Inaugural Address. Mr. J. Sheridan.
December 14th.—"Reconstruction of a large Telegraph Office." Mr. A. T. Kinsey.
January 18th.—"Wireless Telegraphy." Mr. J. J. Dwyer.
February 15th.—"Concrete and its Uses." Mr. W. Pennington.
March 15th.—"Renewal of G.P. Underground by P.C. Cable." Mr. R. A. Weaver.

SOUTH WALES CENTRE.

November 10th.—Visit to Cardiff No. 2 Exchange. Demonstration and explanation. Mr. Devereux.
December 8th.—Cardiff new underground. Laying of cement conduits. Mr. Youngs.
January 12th.—"Condensers." Mr. Hart.
February 9th.—"Estimates." Mr. Scott.
March 9th.—"Regulations and Accounts." Mr. Bound.

NORTH-WESTERN CENTRE.

October 19th.—Inaugural address by Mr. W. J. Medlyn. Paper, "Control and Discipline." Mr. R. Cunningham.
November 23rd.—"Time Checks and Calculagraphs." Mr. W. J. Medlyn.
December 21st.—"The Manchester Electrical Exhibition." "Transformer Efficiencies." Mr. A. F. Guy.
January 25th.—"The Chemistry of Telegraph Engineering." Mr. W. B. Smith.
February 22nd, March 22nd.—Titles of papers not yet received.

EASTERN CENTRE.

October 13th.—"Secondary Cells." Mr. W. J. Stubbs.
December 8th.—"A Visit to a Wireless Station." Mr. E. T. Titterington.
February.—"Copper Wire Manufacturing and Testing." Mr. E. H. Shaughnessy.
April.—"Notes on Building Construction." Mr. G. W. Bannister.

NORTHERN CENTRE.

October 26th.—"The Economic Aspect of Open Line Construction." Mr. Tremain.
November 16th.—"Protection from Power Circuits." Mr. T. B. Johnson.
December 14th.—"Paybills." Mr. Motyer.
January 11th.—"Some Alternating Current Measuring Instruments." Mr. Lee.
February 1st.—"Central Battery Systems with Modifications." Mr. Bellwood.
March 1st.—Mr. Andrews.
March 29th.—"The Unit Maintenance Cost Return." Mr. Williams.

NORTH WALES CENTRE, PROGRAMME 1908-09.

December 9th, 1908—Presidental Address. Mr. W. Slingo.

Dates not yet fixed
- "Electro-Magnets." Mr. H. Hinton.
- Paper on Selected Subject. Mr. T. Plummer.
- "Gas and Hot Air Engines." Messrs. Osborne and Whiteside.
- "The Economical Carrying Out of Works by the Concentration of Gangs." Mr. G. H. Vaughan.
- Paper on Selected Subject. Mr. J. S. Elston.

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SOUTH MIDLAND CENTRE, PROGRAMME 1908–09.

September 9th, 1908—"A few Practical Hints on Underground Work." Mr. G. W. Hook.

October 14th, 1908—"Engineering Accounts." Mr. T. E. Matthews.

December 16th, 1908—"The Birmingham Telephone Switch Room." Mr. A. H. Roberts.

SOCIAL NOTES.

METROPOLITAN (SOUTH) DISTRICT.

Retirement of Mr. T. Harrison, late Superintending Engineer of South Metropolitan District.

The retirement of Mr. T. Harrison, after a service of forty-seven years with the Department, took place on the 16th October, 1908.

On Friday, November 20th, the Staff took the opportunity of presenting to him a handsome solid silver tea service, salver, and cruet, together with an illuminated address, as a token of their respect and friendship. A smoking concert was held at the French Horn Hotel, Wandsworth Common, at which Mr. Sinnott, Assistant Superintending Engineer, presided. All sections of the District were represented; several engineers who had recently left the District were also present, and the company was honoured by the presence of Messrs. M. F. Roberts and A. J. Stubbs, Assistant Engineers-in-Chief; Messrs. Stockwell, McIlroy, and Purves, of the Engineer-in-Chief's office; Mr. Stretche, of the Southern District (R.E.'s); and Mr. Chapman, Holloway Factory.

During the evening Mr. Sinnott spoke of Mr. Harrison's long and honourable career in the public service, and he stated that one and all envied Mr. Harrison in his possessing, at such an age, the full strength and vigour of a young man. He would a little later in the evening ask Mr. Stubbs to be so good as to make the presentation.

Mr. McIlroy said he had known Mr. Harrison for a considerable number of years, for a part on paper only; but since Mr. Harrison came to London in 1899, having been specially selected to carry out the inauguration of the London Telephone Service, he had had the pleasure of closer acquaintance, and for about three years occupied the position of Assistant Superintending Engineer under Mr. Harrison. There never was a harder worker, and the harder the work the more pleasure there seemed to be for Mr. Harrison; and he was sure he voiced the feelings of those present when he said that they were proud to think that he had been able to do all this, and still retain such vitality. It was rarely that capable men in the public service were left with the health that is Mr. Harrison's on their retirement, and few have had such prospects for enjoying a well-earned pension.

Mr. Stubbs, making the presentation on behalf of the Staff and a few outside friends, said it was a great pleasure to everyone to see Mr. Harrison in such good health, and with every prospect of being able to enjoy his rest on a pension so well earned.

Mr. Harrison, in rising to reply, was very heartily received. He said he must first apologise for the manner in which he left headquarters on the last day of his official life. It had been his intention to take farewell of every member of the Staff, but he found, when the time came, he was so overcome by the many expressions of appreciation and goodwill that reached him, that he found the task too difficult—in fact, physically impossible. He assured them that he appreciated their good wishes, and he hoped that this would explain his apparent neglect on the day of his retirement. This was the proudest moment of his life. He felt that his endeavour to do his duty, both to the Department and to the Staff, had been realised, and he should treasure the beautiful present and illuminated address, not only for their high intrinsic value, but also for the spirit in which the presentation was made. Never during his life had he imagined having control of such a highly qualified Staff as had been his lot, and he had often taken the opportunity of expressing to Sir John Gavey (the late Engineer-in-Chief) his grateful thanks; and he never would have

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carried through the enormous amount of work which had been done in connection with the telephoning of London without the hearty and willing co-operation of that Staff.

Mr. Roberts congratulated Mr. Harrison on the very valuable present he had received, and remarked that he felt that the gathering was somewhat onesided, inasmuch as Mrs. Harrison was not present. He was sure that, in wishing Mr. Harrison good health in his retirement, all coupled with it the name of Mrs. Harrison, as this lady's cheery welcome at the very pleasant functions held at the South Metropolitan headquarters made everyone feel at home. He could testify to the kindliness of heart and solicitude for the welfare of his staff which Mr. Harrison always displayed.

Mr. Harrison, who was visibly affected, thanked Mr. Roberts for his very kind remarks and appreciation of his services to the Department. He also added a few words recording the able assistance he had received from Mr. McIlroy (late Assistant Superintending Engineer of the District), Mr. Sinnott (present Assistant Superintending Engineer)—who was described as the "scientific man"—and Mr. Heath, the Chief Clerk. His humorous reference to the latter gentleman's memory for dates was greatly relished by the company. He said that he never realised until this evening the effect on his feelings his retirement would have when the time came to say good-bye to his colleagues in official life.

A concert followed, and broke up with the singing of "Auld Lang Syne," and three ringing farewell cheers for Mr. Harrison.

A series of whist drives and dances have been arranged by the "Metso" Sports Club. The first whist drive took place at Stanley's Restaurant, Clapham Junction, on October 17th, 1908.

Mrs. Sinnott distributed the prizes, which were gained by Miss Dodds (1st), Miss E. Little (2nd), Mrs. Radcliffe (Consolation); Mr. Lilwall (1st), Mr. J. Sinnott (2nd), and Mr. C. W. Impett (Consolation).

Misses Bryce, Claydon and Wheeler, Messrs. Cox, Edwards, Gamgee, Hibberd, Lilwall, Leckie and Parker afterwards contributed to a very successful musical programme which was much appreciated. Whist drives have been arranged to take place in December, 1908, February and April, 1909.

METROPOLITAN (NORTH) DISTRICT.

An interesting social gathering took place at the Metropolitan (North) District on Wednesday, November 25th, when, in the course of a musical evening, Mr. E. A. Pounds was presented with a gold watch as a mark of esteem from his late colleagues of the district. Mr. E. Catley, who was supported by Messrs. E. J. Eldridge and G. H. Downing, made the presentation, and very neatly expressed the feelings of himself and staff with regard to the loss sustained by Mr. Pounds' transfer to the London Telephone Service. A clock with ornaments and a Worcester vase were also presented to Mr. A. Hart, assistant clerk, on the occasion of his marriage.

IRELAND CENTRE.

Presentations.

On the 13th October last Mr. Alexander Moir was presented with a silver rose-bowl and salver by the Staff of the Southern Irish District prior to his departure from Dublin to take charge of the South Metropolitan District, London. The chair was ably filled by Mr. W. H. Cross, Assistant Superintending Engineer, who paid a high tribute to Mr. Moir's professional and administrative abilities, and to his personal charm of manner, which had endeared him to the whole of the staff. Messrs. Highton (Secretary's Office), W. M. Evans, A. T. Kinsey (Assistant Superintending Engineers, North Irish District), J. J. Dwyer, H. C. McCormack, and C. Burge (late Superintending Engineer, South Irish District) testified to the esteem in which Mr. Moir was held, and to the loss which the district would sustain by his departure. Mr. Moir, in reply, said he left Ireland with much regret, and heartily thanked the staff for their loyal co-operation and support.

The occasion was also made the subject of a presentation of a silver tea service to Mr. J. Cullen, late Sectional Engineer, Wexford, as a token of the respect in which he was

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held by his colleagues. The presentation was made by Mr. Moir, who congratulated Mr. Cullen on earning a well-deserved rest after a strenuous life spent in the service of the Department during a period in which many changes in the science of electrical engineering had taken place.

An excellent musical programme was afterwards provided.

SCOTLAND EAST CENTRE.

Mr. F. D. Horton has been transferred to London for Telephone Survey work. Prior to leaving he was presented with travelling bags and a fountain pen by the Superintending Engineer on behalf of the staff. The usual felicitous speeches were indulged in, extolling Mr. Horton's amiable qualities, and hopes were expressed that his transfer might prove beneficial.

ANNUAL DINNER.

The Sixth Annual Dinner of the Post Office Engineering Department, London, will be held at the Grand Hotel, Trafalgar Square, on the third Tuesday in February, 1909 (February 16th).

Mr. H. North, Survey Section, Engineer-in-Chief's Office, the Honorary Secretary, will issue a circular on the subject in due course.

LONDON UNIVERSITY EXAMINATIONS, 1908.

Congratulations are extended to Mr. F. Addey, 2nd class engineer, Engineer-in-Chief's Office, and Mr. W. H. Matthews, 3rd class clerk, Engineer-in-Chief's Office.

These gentlemen have recently obtained their B.Sc. degrees at London University.

CORRESPONDENCE.

To the Editors of THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL.

THE CULT OF THE CLERK.

THE writer of the above article in the October issue of the JOURNAL suggests that unless a clerk in a Government Department can foresee that any contemplated change be in his interests, he will relapse into quiet desperation, and the article is written with a view to dispelling any such feeling.

May I ask—Is there no limit to the time when a man may be excused for falling into such a state? Hope is a great incentive to study and work, and the Service would be a poor one if every individual were deprived of it. "To cease to hope is to begin to die," but hope in the Department must be given an impetus, or it must vanish. Can I be admonished for falling into quiet desperation if, after spending many hours in acquiring a knowledge of French, shorthand, book-keeping, drawing, mathematics, and technical subjects, I find myself at the end of seven years' service on one class of clerks, with prospects no better than when I entered that class? May I not argue that the spare time so spent might have been more profitably employed, and that to continue in such a course is morally wrong? There are plenty of fields for labour during one's spare time for the good of the community, and one would have the satisfaction of accomplishing something worthy. To spend all one's life in the study of subjects in general, on the chance that some of those subjects may assist promotion, is useless to the officer concerned, the Department, and the world. To the officer concerned—because it makes him selfish. To the Department—because students are apt to concentrate their thoughts on their studies during office hours. And to the world—because men who give up their lives to the study of one subject only are greater authorities, and it is they who enlighten the world.

Let the Department indicate its requirements for a clerk, and I have no doubt the majority will respond, whether it include the Cherokee or Greek. But let it be definite, so that an officer may give his mind to it with certainty. A few years ago one was led to suppose that if a clerk wished to make progress he must study technical subjects. Now it is "accounting," "banking," etc. One wonders what next! If one follows up the different policies, one will at the finish be in a position to look back and think of the "time elaborately thrown away."

General intelligence and acuteness are of greater value to the Department than a knowledge of any foreign language; but a course of study will not produce either of the former, although it may enable one to pass examinations in which is included the latter.

I suggest that if the Department desire to be in a position to learn the value of a clerk,

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it would be better accomplished by a study of official papers which had passed through his hands. Or, as an alternative, let the Department present imaginary difficulties which are likely to be met with, and let the officer indicate the best method of dealing with them.

In conclusion, I would like to point out that the attempt to compare an insurance office clerk with a Government clerk is futile under existing conditions. A clerk in an insurance office is rewarded according to his ability, and his incentive to study is "hope," which is stimulated periodically by promotion, enabling him to realise the benefit of his labours by being in a better position to provide for those depending on him. Instead of devoting his whole life in obtaining knowledge which may perhaps be useful, he commences on definite lines, and gives up a few years to the study of those subjects which are necessary and recognised.

Yours faithfully,

H. J. BULLARD.

To the Editors of THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL.

LOCALISATION OF FAULTS ON UNDERGROUND CABLES.

SIR,—I should esteem it a favour if you would permit me to correct the formulæ in the article mentioned above which appeared on pp. 174–5 of the JOURNAL. The capacities K and K_1 were inadvertently transposed in the first equation mentioned, and the error was carried to the second equation. The following corrections are necessary:

$$\frac{R}{R_1} = \frac{K}{K_1} \text{ should be read as } \frac{R}{R_1} = \frac{K_1}{K} \text{ and}$$

$$K_1 = \frac{R_1 K}{R} \text{ should be read as } K_1 = \frac{RK}{R_1}$$

H. P. BROWN.

20th November, 1908.

CHESS CLUB NOTES.

THE Annual General Meeting of the G.P.O. (Engineering Department) Chess Club was held on the 22nd September at the Club's headquarters, "Ye Mecca," 140, Cheapside, E.C. Major W. A. J. O'Meara, C.M.G., was re-elected President, and the names of Messrs. H. Hartnell and A. Moir were added to the list of Vice-Presidents.

Mr. S. C. Bartholomew will this season act as Match Captain and Mr. W. H. Stephenson as Hon. Secretary. Mr. M. F. G. Boddington will again fill the position of Hon. Treasurer. A vote of thanks to Mr. W. D. Frewin, the retiring Hon. Secretary, and Mr. E. Turner, last season's Match Captain, was carried unanimously.

The Club has this year entered the Second Division of the Civil Service and Municipal Chess League, and opened the season on October 27th with a match against the National Telephone Company. This was won by 6 games to 4. The results of three other League matches are appended.

In the match played November 10th the Engineering Department lost to the Metropolitan Water Board by 3½ games to 6½, and in the match played November 24th the Engineering Department and the G.P.O. North II tied with 5½ games each.

The Local Government Board II were met and defeated by 6 games to 4 on December 8th.

Very good entries were received for the Club Championship and Handicap Tournaments which are now in full swing. The Championship was instituted last season, when the conditions were that each competitor should play all the other competitors. As there were sixteen entries this proved too big a task for most of the players, and, as a consequence, the competition is this season being conducted on the cup-tie principle. The trophy consists of a set of chess-men, and a large chess-board with a deep moulding, on which silver shields bearing the winner's names will be affixed. The first holder is Mr. R. A. Wells, to whom the President presented it on December 11th.

The 1907–8 Tournament, the completion of which was unavoidably held over until the beginning of this season, resulted as follows:—Mr. W. D. Frewin (Class A) 1, Mr. W. H. Stephenson (Class C) 2, Mr. A. L. DeLattre (Class A) 3, Mr. F. E. Mitton (Class B) 4.

The display given by Dr. Lasker last year proved so popular that arrangements have been made with Mr. T. Gunsberg for a similar exhibition on Tuesday, February 2nd, at 140, Cheapside. Mr. Gunsberg will deliver a short lecture, and afterwards play twenty games simultaneously. Ten of the boards will be taken by members of the G.P.O. North Chess Club, in conjunction with whom the engagement has been made.

Anyone desiring to join the Club is invited to communicate with the Hon. Secretary at the G.P.O. West. The annual subscription is 3*s*.

W. H. S.

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STATION LIST.

BRITISH POST OFFICE.

ENGINEERING DEPARTMENT.

Engineer-in-Chief . .	Major W. A. J. O'Meara, R.E., C.M.G., M.I.E.E.
Assistant Engineer-in-Chief.	M. F. Roberts, M.Inst.C.E., M.I.E.E., F.C.S.
,, ,, ,, .	J. W. Woods, M.I.E.E.
,, ,, ,, .	A. J. Stubbs, M.I.E.E.
Electrician	H. R. Kempe, M.Inst.C.E., M.I.E.E.

Name.	District.	Station.
Supt. Engrs.—		
Jenkin, J. .	E.	Cambridge.
Stewart, D. M.	Sc. W.	Glasgow.
Carr, G. M.	N.E.	Leeds.
Vyle, W. W.	S.Wa.	Cardiff.
Harrison, T.	Met. S.	London.
Hook, G. W.	S.M.	Birmingham.
West, T. J..	N.M.	Nottingham.
Slingo, W. .	N.Wa.	Liverpool.
Tremain, F.	N.	Newcastle-on-Tyne.
Moir, A. .	I.S.	Dublin.
Catley, E. .	Met. N.	London.
Groves, J. W.	N.W.	Manchester.
Noble, W.	Met. C.	London.
Sheridan, J.	Ire. N.	Dublin.
Machugh, F. H. .	Sc. E.	Edinburgh.
Probert, I. .	Electric Lighting	London.
Subm. Supts.—		
Culley, W. R., I.S.O.	'Monarch'	Woolwich.
Pollard, F. .	'Alert'	Dover.
Staff Engrs., 1st Cl.—		
Stockwell, T. H. .	E. in C.O.	—
Hartnell, H.	,,	—
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	PAGE
FRONTISPIECE—Sir John Gavey, C.B. (Portrait).	
Foreword	1
Words of Welcome—Sir John Gavey, C.B.	2
EDITORIAL—	
Annual Dinner	3
Central Battery Telegraphs	4
TELEGRAPHS—	
The Polarised Sounder—C. C. Vyle and E. V. Smart (5 Illustrations)	6
The Common Battery Duplex—C. E. Hay (3 Illustrations)	12
The Typewriter and Piece-work in Telegraphy—Donald Murray, M.A.(Sydney)	18
CONSTRUCTION—	
The Telephoning of London—W. Noble, A.M.I.E.E. (2 Illustrations) ...	22
TELEPHONES—	
Telephone Progress in London—G. F. Preston, M.I.E.E.	28
Common Battery Telephone Transmission Systems and Some Methods of their Application by the Post Office—M. Ramsay (10 Illustrations)	31
Glasgow Trunk Exchange—New Equipment—J. S. B. (3 Illustrations) ...	38
The Zones and the Trunk Lines—J. Lee	42
WIRELESS—	
The Skerries Wireless Telephone—J. S. Elston (2 Illustrations) ...	46
ABSTRACT—	
A New Common Battery Telephone—J. W. T. (2 Illustrations) ...	50
INSTITUTION NOTES—	
Local Centre Notes	53
Library Notes	56
SOCIAL—	
Chess Club Notes. Visits to Manufacturers' Works, etc. ...	58
CORRESPONDENCE	59
STAFF CHANGES	61
DESIGNS COMPETITION	62
THE AWARDS COMMITTEE	64
INTERNATIONAL TELEGRAPHY! (A Poem)	65
HOWLERS, TECHNOLOGICAL	66
P.O. ENGINEERING DEPARTMENT, LONDON—	
Fifth Annual Dinner	68
OBITUARY—	
W. R. Smith (A. W. H.)	79
J. H. Cordeaux (H. R. K. and A. J. S.)	80

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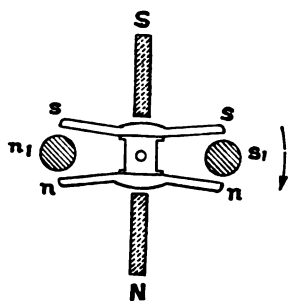

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FRONTISPIECE—Some of the Engineering Staff, Irish Districts. PAGE

EDITORIAL—
Examinations 81
Sir W. H. Preece, K.C.B., F.R.S. 82
Finance 83
Types of Underground Cable 84

EDUCATION—
Education and Training of Telegraph Engineers in France—Major W. A. J. O'Meara, C.M.G. 86

TELEGRAPHS—
The Motor-Driven Wheatstone Transmitter—C. C. Vyle and E. V. Smart 97

CONSTRUCTION—
The Design of Telephone and Telegraph Cables—A. G. Lee, B.Sc. 103
Pneumatic Tube Joints—W. N. 113
Reminiscences of Underground and Overhead Telegraph Works—G. W. Hook 114
Potheads and Pothead Insulators—E. Gomersall 118
Telephoning of London—W. Noble, A.M.I.E.E. 122

TELEPHONES—
Richmond Telephone Exchange: New C.B. Equipment—J. W. Turner, A.I.E.E. 129

FINANCE—
Army Finance: Abstract of Lecture by Charles Harris 135

WIRELESS—
The Radio-Telegraph Convention—and After 141
Plane Electro-Magnetic Waves: Relation to Wireless Telegraphy—J. Zenneck. Translated by H. Hartnell, A.M.I.E.E. 147

INSTITUTION NOTES—
Proceedings of Council 152
Annual Report 153
Local Centre Notes 154

SOCIAL—
Sports—Chess Club Notes—Visits to Manufacturers' Works, etc. 156

CORRESPONDENCE 157
STUDENTS' SECTION 160
STAFF CHANGES 162

OBITUARY—
Thomas William Lapham (W.B.) 163
Henry Pomeroy (T.P.) 164

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FRONTISPIECE—View looking E., showing Beams in Ground and First Floors, with Roof of the G.P.O. (N.) in the Background.

PAGE

BUILDINGS—

The New General Post Office (King Edward's Building)—E. W. Pettit 165

EDUCATION—

The Cult of the Clerk—T. B. 170

TELEGRAPHS—

Localisation of Faults on Underground Cables—H. P. Brown ... 173

Central Telegraph Office 176

Tapping on to Kroonstad: A Reminiscence of the Boer War—J. H. B. 177

CONSTRUCTION—

The Holding-power of a Small Wall-bracket—John H. M. Wakefield 180

Reminiscences of Overhead and Underground Telegraph Works—G. W. Hook. (*Continued from p.* 117) 182

TELEPHONES—

New Common Battery Exchange at Cardiff—T. Devereux ... 185

Development of the Post Office Long-distance Trunk Exchange System. (*A*) Traffic—J. Stuart Jones 190

Development of the Post Office Long-distance Trunk Exchange System. (*B*) Engineering—W. J. Medlyn 196

Richmond Exchange—Transfer from C.B.S. to C.B. Working—J. Hedley 204

Chloride Accumulators—H. E. Martin 209

WIRELESS—

The Post Office Radio-Telegraph Stations at Tobermory and Lochboisdale—A. C. Booth 213

Effect of Wireless Telegraph Transmission on a Telephone System 217

On the Propagation of Plane Electro-magnetic Waves along a Plane-conducting Surface, and its Relation to Wireless Telegraphy—J. Zenneck. Translated by H. Hartnell, A.M.I.E.E. (*Continued from p.* 151) 218

"HOWLERS, TECHNOLOGICAL"—Examiner 221

A TRAIN HELD BACK BY A SPIDER 221

REVIEW—

The Hughes and Baudot Telegraphs 222

NOTES AND COMMENTS—

Telegraphs and Lightning 224

First International Congress of European Telegraph and Telephone Engineers at Budapest 225

Station List Supplement 227

Sir W. H. Preece, K.C.B., F.R.S. 227

STAFF CHANGES 227

FOREIGN AND COLONIAL NOTES 228

CORRESPONDENCE 229

STUDENTS' SECTION 232

SOCIAL NOTES 233

CLUB NOTES 234

INSTITUTION NOTES 234

OBITUARY—

Mr. Joseph Ward, Engineer-in-Chief's Office 235

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CONTENTS FOR JANUARY, 1909.

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	PAGE
CONFERENCE—	
The First International Conference of Telegraph and Telephone Technicians, held at Buda-Pest, September, 1908—T. F. Purves and J. G. Hill...	237
UNITS—	
The International Conference on Electrical Units and Standards, held in London, October, 1908—Major W. A. J. O'Meara, C.M.G.	290
CONSTRUCTION—	
Reminiscences of Overhead and Underground Telegraph Works—G. W. Hook. (*Continued from p.* 185)	298
WIRELESS—	
On the Propagation of Plane Electro-magnetic Waves along a Plane-conducting Surface, and its Relation to Wireless Telegraphy—J. Zenneck. Translated by H. Hartnell, A.M.I.E.E. (*Continued from p.* 220)	303
NOTES AND COMMENTS—	
The Buda-Pest Technical Conference...	308
Institution Meetings	311
Colonial Notes	312
Our First Volume...	313
STAFF CHANGES	314
FOREIGN AND COLONIAL NOTES	316
STUDENTS' SECTION	319
LINE CONSTRUCTION WORKS	320
INSTITUTION NOTES	320
LOCAL CENTRE NOTES	324
VISITS TO MANUFACTURERS' WORKS, ETC.	327
LOCAL CENTRE PROGRAMMES, 1908-9	328
SOCIAL NOTES	329
CORRESPONDENCE	331
CHESS CLUB NOTES	332

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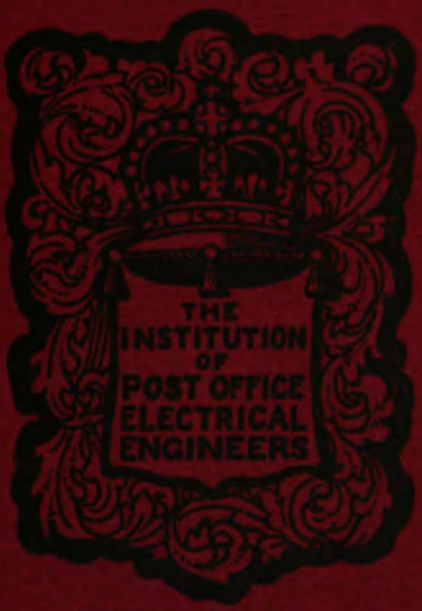

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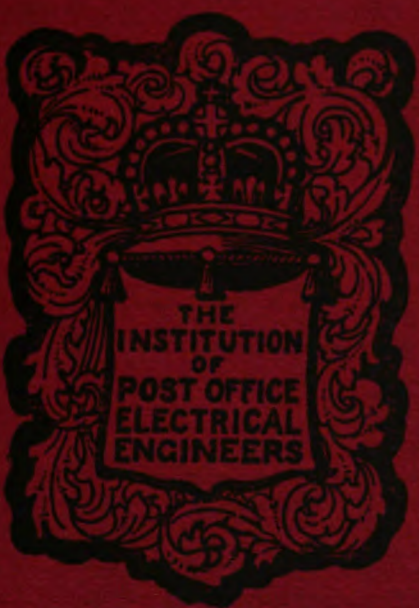

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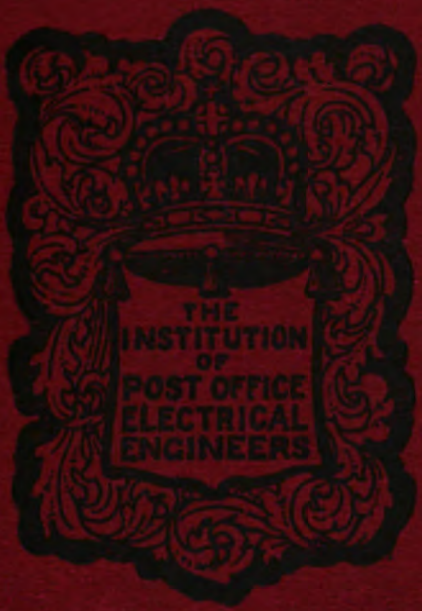

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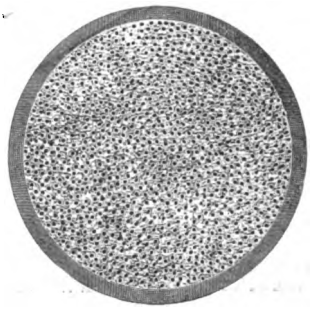

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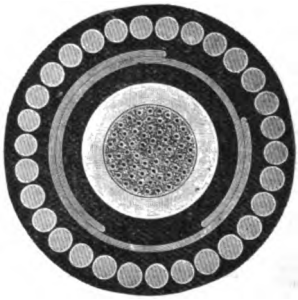

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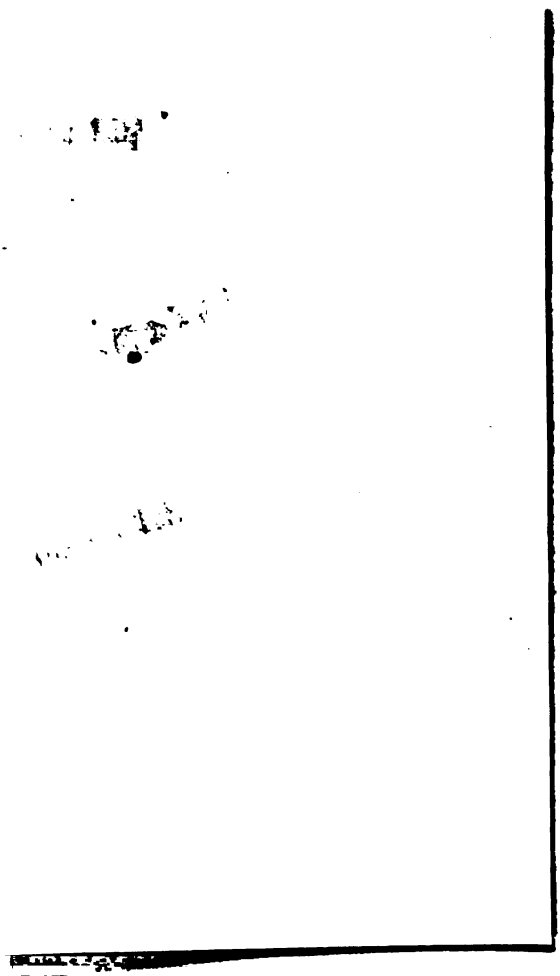

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